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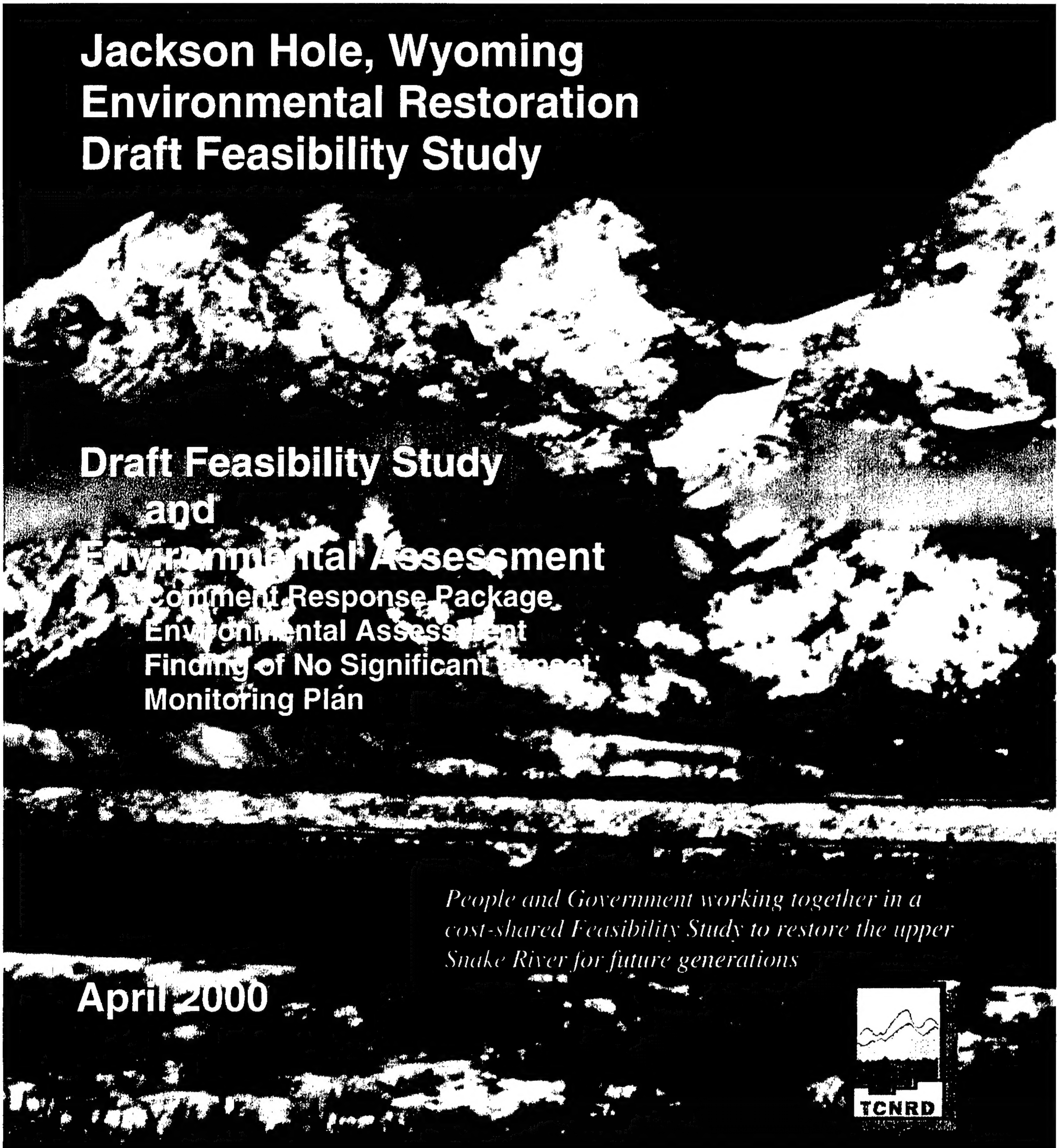
Walla Walla District

Teton County
Wyoming

Jackson Hole, Wyoming
Environmental Restoration
Draft Feasibility Study



Draft Feasibility Study
and
Environmental Assessment

Comment Response Package
Environmental Assessment
Finding of No Significant Impact
Monitoring Plan

People and Government working together in a cost-shared Feasibility Study to restore the upper Snake River for future generations

April 2000

TCNRD

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The *Jackson Hole, Wyoming, Environmental Restoration Feasibility Report Draft April 2000* is the draft product of a 4-year, cost sharing feasibility study conducted by the U.S. Army Corps of Engineers, Walla Walla District, in partnership with Teton County, Wyoming, and Teton Conservation District, Wyoming. The report recommends an environmental restoration project on a 22-mile reach of the upper Snake River from Grand Teton National Park to South Park Elk Feedgrounds. The goal of the recommended project is to restore diverse and sustainable aquatic, wetland, riverside, and terrestrial habitats within the study area.

If you would like additional of the final version of the report copies (free of charge until no longer available), please contact, Mr. Stan Heller, Project Manager, U.S. Army Corps of Engineers, 201 North Third Avenue, Walla Walla, Washington 99362 (or send e-mail to: Stanley.G.Heller@nww01.usace.army.mil or telephone at 509-527-7258). The EA (Appendix H) of the report is also available at website: http://www.nwwusace.army.mil/reports/jackson.

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May 12, 2000

Reply To
Attention Of:

Planning, Programs, and Project
Management Division

Dear Interested Party:

Enclosed is a copy of the draft *Jackson Hole, Wyoming, Environmental Restoration Feasibility Study*. This report concludes a 4-year, cost sharing feasibility study conducted by the U.S. Army Corps of Engineers, Walla Walla District, in partnership with Teton County, Wyoming, and Teton Conservation District, Wyoming. The draft feasibility study recommends an environmental restoration project on a 22-mile reach of the upper Snake River from Grand Teton National Park to South Park Elk Feedgrounds. The goal of the recommended project is to restore diverse and sustainable aquatic, wetland, riverside, and terrestrial habitats within the study area. Dependent upon favorable public review, the U.S. Army Corps of Engineers will recommend that this project be included in the Water Resources Development Act (WRDA) of 2000 for construction authorization.

The Progressive Plan (described in the report) would result in a cost sharing construction project implemented in phased construction over a period of 10 to 15 years. This construction and environmental restoration project is dependent upon the non-Federal cost sharing partners contributing 35 percent of the construction cost and the United States Congress appropriating 65 percent as the Federal share.

Included with the report are the final Environmental Assessment, the Comment Response Package, the draft Finding of No Significant Impact (FONSI), and the Monitoring Plan. The public review period for the draft Environmental Assessment was conducted between March 5, 1999, and April 6,1999.

A public information meeting on the draft feasibility study will be held May 25, 2000. The meeting will begin at 1:30 p.m. and extend into the evening until all business is concluded. The meeting will be held in the chambers of the Teton County Commissioners, 200 South Willow, Jackson, Wyoming. Comments on the draft feasibility study should be

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Environmental Restoration
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Prepared By

U.S. Army Corps of Engineers
Walla Walla District

Teton County, Wyoming

Teton County Natural Resources District

April 2000

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Jackson Hole, Wyoming, Environmental Restoration Feasibility Study

EXECUTIVE SUMMARY

Background: In 1990, the U.S. Congress authorized the U.S. Army Corps of Engineers (Corps) to conduct the *Jackson Hole, Wyoming, Environmental Restoration Feasibility Study* (*Feasibility Study*) through the General Investigations Program. The purpose of the study was to investigate the feasibility of restoring fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of the Jackson Hole Flood Control Project levees completed in 1964.

The study area is located in and along the Snake River near Jackson, Wyoming, in Teton County (see Plates 1 and 2 in the *Feasibility Study* for vicinity and project location maps). The primary local sponsor is Teton County, Wyoming. The study area borders the National Elk Refuge and is in close proximity to Grand Teton and Yellowstone National Parks.

Prior to construction of the levee system, the study area was characterized by a complex system of braided river channels and wooded islands that provided highly diverse and productive habitat for both aquatic and terrestrial species. The levees have contributed significantly to reducing flood damage within the river corridor, but they have also changed the physical character of the river system, resulting in river instability and severe habitat loss and degradation.

Existing and Historic Conditions: An assessment of existing and historic conditions was conducted for the study. Categories of conditions evaluated included hydrology and hydraulics, environmental resources, geology, geomorphology, and socioeconomics. Technical studies identified the major source of problems in the study area to be river channel instability. The main river channel has a tendency to fill and shift. This tendency has been intensified dramatically within the levee system. As the river changes its course, it can impinge on river island habitats, often resulting in complete destruction. With the loss of these island habitats, many species can no longer survive, especially during the area's harsh winters. Environmental studies confirmed that systematic channel instability has resulted in reduced diversity of species and diminished production of vegetation in area habitats. Without intervention, the remaining habitats in the study area will continue to become gravel bars with a drastic reduction in the diversity of animal and plant species.

Study Objectives: The overall goal of the recommended Jackson Hole Environmental Restoration Project supported by this study is to restore diverse and sustainable aquatic, wetland, riverside, and terrestrial habitats within the study area. Specific objectives are to investigate the feasibility of: (1) restoring river channel stability; (2) protecting remaining diverse habitats; (3) restoring diversity and sustainability to degraded habitats; and (4) restoring degraded habitats for threatened and endangered species.

Study Methods: The study area encompassed 25,000 acres of the floodplain of the Snake River near Jackson, Wyoming. The area was reduced to 12 potential restoration areas, with selection based upon the extent of habitat degradation and the highest probability of successful restoration. These 12 areas were then screened to identify the top 4 priority sites for detailed study; identified as Areas 1, 4, 9, and 10 (see Plates 3 and 4 in the *Feasibility Study* for maps of these locations). Innovative management measures were developed to protect and restore riverside and aquatic habitats at these sites. Based on the information developed through evaluation of a habitat restoration demonstration project, engineering studies, experience from the operation and maintenance of the flood control project, and other studies, management measures were identified for each of the sites to formulate the restoration plan for the entire river corridor.

Evaluation Criteria: Sixteen alternative restoration plans were evaluated based upon the criteria of environmental effectiveness and economic efficiency. Environmental habitat impacts were evaluated using three habitat models; one developed as part of this *Feasibility Study* for aquatic habitat and two developed by the U.S. Fish and Wildlife Service for riparian habitat. Cost effectiveness and incremental cost analysis identified the plans that were the best investments for producing varying levels of aquatic and riverside habitats.

Restoration Plans: Two restoration plans were determined to be feasible: the *Initially Proposed Plan* (developed within this study) and a second, more extensive, *Progressive Plan,* that is the result of subsequent management and sponsor review of this study as well as coordinated partnering among regional agencies, interest groups, and the study team.

a. Initially Proposed National Ecosystem Restoration Plan: The initially proposed National Ecosystem Restoration Plan (NER Plan) involves implementation at study Areas 1, 4, 9, and 10.

The initially proposed NER Plan is estimated to create a total of 104,277 aquatic habitat units (an increase of 20 percent) over the future without-project condition and a total of 11,464

riparian habitat units (an increase of 108 percent) over the future without-project condition. The proposed restoration will also improve habitat for multiple threatened and endangered species that depend on healthy and diverse river-related ecosystems. Threatened and endangered species that have been witnessed in the project area include the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf.

The initially proposed NER Plan is estimated to have a total cost of $26.3 million.

b. ***Progressive Plan:*** The Progressive Plan involves restoration of the entire 22-mile reach of the Snake River starting approximately 2 miles downstream of Moose, Wyoming, to Flat Creek at South Park National Elk Feedgrounds. The Progressive Plan provides the greatest opportunity for environmental restoration of all impacted areas of the Snake River below Grand Teton National Park and above the canyon section of the river managed by the U.S. National Forest Service.

The Progressive Plan is estimated to create a total of 398,970 aquatic habitat units (an increase of 20 percent) over the future without-project condition. The Progressive Plan will also create an estimated total of 43,862 riparian habitat units (an increase of 108 percent) over the future without-project condition. The proposed Progressive Plan will improve habitat for the threatened and endangered species (*i.e.*, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf) mentioned in the initially proposed NER Plan, but with habitats restored over the entire 22-mile reach of the Snake River. The Progressive Plan provides the opportunity for greater ecosystem influence due to the restoration of highly degraded habitat over a larger geographic area. The expanded restoration effort will provide greater synergistic effect on adjacent habitats landward of the levees. The area to be restored under the Progressive Plan includes all areas where levees were constructed to provide flood protection without compromising flood protection.

Prior to restoration, all project areas added under the Progressive Plan will require the same degree of analysis as was performed in the *Feasibility Study*. Efficiencies will be realized since additional analysis will occur only in the Planning, Engineering, and Design Phase and not be repeated in another feasibility study. The following will be needed: hydraulic studies; fish and wildlife analyses to determine the most appropriate areas to provide restoration features; and a National Environmental Policy Act (NEPA) review.

The Progressive Plan will use a phased construction approach, implementing restoration in Areas 1, 4, 9, and 10 before other areas. The Progressive Plan will enable potential local sponsors to restore sections of the river more quickly and efficiently without the cost and time required for additional feasibility studies. Advancements in ecosystem restoration will occur as a result of the Planning, Engineering, and Design Phase applied to the first four sites and lessons learned from adaptive management of those sites through monitoring.

The cost per mile of restoration under the Progressive Plan varies along different parts of the river. The total cost of the Progressive Plan is estimated at $52.3 million.

Cost Sharing: The local sponsor, Teton County, has indicated a willingness to pay a percentage (35 percent) of construction costs consistent with current Federal cost-sharing guidelines. A long-term monitoring and maintenance plan has been developed to ensure that the project performs as designed. The first 5 years of this plan have been included in the construction cost of the project. After this 5-year period, Teton County has indicated a willingness to assume all responsibilities for monitoring, operating, and maintaining the project consistent with current operation and maintenance regulations. Teton County accepts responsibility for obtaining all lands, easements, rights-of-way, relocations, and disposals as required for project construction, operation, and maintenance of all areas proposed for construction.

Environmental Compliance: An Environmental Assessment (EA), Section 404(b)(1) Evaluation, and a draft Finding of No Significant Impact (FONSI) have been prepared and approved for the Jackson Hole Environmental Restoration Project for Areas 1, 4, 9, and 10. These documents describe the effects of restoring habitats in the four areas proposed for project implementation under the initially proposed NER Plan. Public forums and meetings were held to allow interested parties to ask questions and provide comments on the proposed project. Supplemental EA's or appropriate NEPA documents will be prepared for any additional implementation areas identified in the Progressive Plan during the Planning, Engineering, and Design Phase.

Recommendation: Both the initially proposed NER Plan and the Progressive Plan will restore and protect important fish and wildlife habitats impacted by the Snake River Federal Flood Control Project. Both plans will provide restored habitats for multiple threatened and endangered species. Both plans will enhance diversity of animal and plant species in a geographical area in which fish and wildlife play a large part in regional and national economies. The Progressive Plan would result in optimal restoration over a more extensive portion of this

outstanding natural environment. Based upon this *Jackson Hole, Wyoming, Environmental Restoration Feasibility Study,* implementation of the Progressive Plan is recommended as a first choice with the Initially Proposed Plan providing a second viable alternative.

Feasibility Study: The following *Feasibility Study* summarizes the planning process, results, and recommendations for environmental restoration of the Jackson Hole study area. The study examines: existing conditions; prior studies and reports; projected conditions without restoration; plan formulation; the initially proposed NER Plan; plan implementation and coordination; and public views and comments. Details of technical studies are provided in the following Appendixes: Hydrology, Ground Water, Engineering, Economic, Real Estate, Environmental Assessment, and Fish and Wildlife.

1. INTRODUCTION

1.1 Study Authority

The Jackson Hole Flood Control Project was authorized in the Flood Control Act of 1950, and provided flood protection by levees and revetment along the Snake River in Jackson Hole, Wyoming. The Jackson Hole Flood Control Project was completed in the fall of 1964, and the sponsor was Teton County. Additional levees were added to the system by other agencies and by emergency flood fight operations of the U.S. Army Corps of Engineers (Corps) and Teton County through 1997.

Authority to operate and maintain the Jackson Hole Flood Control Project was granted by Section 840 of the Water Resources Development Act of 1986, Public Law (PL) 99-662 (WRDA 86), to the Secretary of the Army, including additions and modifications constructed by non-Federal sponsors, provided that the local sponsor provides the first $35,000 in any one year (adjusted for inflation). The Corps signed a Local Cooperative Agreement with Teton County in September 1990, after completion of a Decision Document and Environmental Impact Statement (EIS). The Corps assumed operation and maintenance (O&M) responsibility for the levee system on the Snake and Gros Ventre Rivers in Jackson Hole, Wyoming.

The Jackson Hole, Wyoming, River and Wetland Restoration Study was authorized by the U.S. Senate Committee on Environment and Public Works in a Study Resolution of June 12, 1990. The scope of the study was to determine the feasibility of providing environmental restoration to wetland and riparian habitats located between the flood control levees. Teton County, the local sponsor for the proposed environmental restoration project by the Corps, would provide funds in accordance with cost sharing requirements specified in WRDA 86, as amended.

As required by the National Environmental Policy Act of 1969 (NEPA) and subsequent implementing regulations promulgated by the Council on Environmental Quality (CEQ), an Environmental Assessment (EA) was prepared to determine whether the proposed environmental restoration project constitutes a "major Federal action significantly affecting the quality of the human environment" and whether an EIS is required.

1.2 Study Purpose and Scope

The purpose of this *Jackson Hole, Wyoming, Environmental Restoration Feasibility Study (Feasibility Study)* is to investigate the feasibility of restoring fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of levees of the Jackson Hole Flood Control Project, including levees constructed by non-Federal interests. The study area is located along the Snake River, near Jackson, Wyoming, in Teton County.

While the levees have contributed significantly toward reducing flood damage potential along the river corridor, over time the levees have significantly changed the physical character of the river system and contributed to the loss of environmental resources. The environmental restoration project supported by this *Feasibility Study* is needed to prevent further degradation and destruction of environmental resources within the study area and to facilitate recovery of lost aquatic and terrestrial habitat. A restoration project has high potential for restoring fish and wildlife habitat through enhancement and restoration of the aquatic and riparian environment, including wetland and riparian vegetation and in-stream fisheries habitat.

1.2.1 Study Goal

The overall goal of the *Feasibility Study* is to investigate the feasibility of restoring diverse and sustainable riverine (aquatic, wetland, riparian, and terrestrial) habitats within the study area.

1.2.2 Specific Objectives

Specific study objectives include investigating the feasibility of:

- Restoring channel stability and in-stream habitat values.
- Protecting remaining diverse (wetland/riparian/terrestrial) island habitats.
- Restoring diversity and sustainability to degraded island habitats.
- Restoring degraded habitats for threatened and endangered species.

1.3 Study Area

The original study area defined in the reconnaissance report encompassed 25,000 acres of the 500-year floodplain of the Snake River and its tributaries in the vicinity of Jackson Hole, Wyoming. The study area was limited to the reach between the town of Moose (near the southern boundary of Grand Teton National Park), and the U.S. Highway 26 Bridge over the Snake River about 7 miles south of Jackson. Twelve potential restoration sites (Plates 1, 2, and 3) were included in the study area. The current *Feasibility Study* area examines only four potential restoration sites: Areas 1, 4, 9, and 10, and is limited to the Snake River between the Gros Ventre River confluence and the aforementioned Highway 26 Bridge (Plate 4).

1.4 Study Area Physical Characteristics

Jackson Hole is a valley about 10 miles wide and 35 miles long situated along the Snake River in northeastern Wyoming (see Plate 2). It is bounded by the Teton Range on the west, the high plateaus of Yellowstone National Park to the north, and the Gros Ventre Range to the east. Valley elevations range from about 5,900 feet at the Highway 26 bridge over the Snake River to 6,800 feet in the vicinity of Jackson Lake, with an average elevation of about 6,200 feet in the Federal levee project area. Peak elevations rise to over 13,000 feet.

1.4.1 Climate

The climate of the area from Jackson to Moran, Wyoming is typical of high-elevation, Rocky Mountain valleys. During summer months the area has an abundance of sunshine with low humidity and high evaporation during the daytime. The growing season between killing frosts is limited by extreme diurnal fluctuations in temperature and resulting cold nights. Surrounding mountain areas seldom experience a month without freezing temperatures. Thunderstorms are frequent during the summer months, but individual occurrences affect only limited areas. Resultant storm runoff in the Snake River and major tributaries is small in comparison to stream flows resulting from snowmelt.

Climatological records at Jackson show an average annual temperature of 38 degrees Fahrenheit (°F) with period-of-record extremes of minus 52 °F and 101 °F. Temperatures as low as minus

63 °F have been recorded at Moran. Daily minimum temperatures below freezing usually occur at Jackson from early September to mid-June and freezing temperatures have been known to occur in any month of the year. The average frost-free period (growing season) is about 50 days at Jackson.

The Jackson Hole area is affected principally by moist Pacific maritime air masses brought into the region by prevailing westerly winds, and the valley is somewhat within the rain shadow of the Teton Range. Frequently, cool polar or warm continental air masses invade the region, displacing or modifying the effects of the maritime air masses. These latter types are mainly responsible for the valley's clear weather and low humidity, as well as its diurnal and seasonal temperature extremes. Jackson Hole is located just west of the Continental Divide, and, in addition to storms from the west, the basin can be affected by orographic lifting of air masses from the north and east. During the summer, subtropical air from the southern Rockies can also be a source of moisture for thunderstorms. However, runoff from these storms tends to be highly localized, and Teton County authorities report that storm runoffs do not reach approach damaging levels.

1.4.2 Topography

The topography of the Jackson Hole valley is dominated by depositions of fluvial material by the upper Snake River, by historical and present tectonic uplifting, and by glaciation. The valley floor is presently underlain by deep deposits of alluvial and glacial Quaternary gravels, sands, and debris. Jackson Hole was formed by differential tectonic uplifting of the Teton Range, which has influenced the present position and channel form of the Snake and tributary rivers. Prior to levee construction, the major rivers and tributaries of the Jackson Hole floodplain had cut braided channels through glacial outwash plains. Braided channels result from a combination of high sediment loads, relatively steep channel gradients, and noncohesive banks. Braided channels are subject to frequent avulsion (channel switching) and lateral channel migration. They are very prone to flooding because of their relatively shallow depth when compared to width, and because of their characteristically unstable or noncohesive banks.

1.4.3 Drainage

The headwaters of the Snake River originate in Yellowstone National Park to the north of Jackson Hole. After passing through Jackson Lake, the river enters the Jackson Hole floodplain. Principal upstream tributaries are the Lewis River, Pacific Creek, and Buffalo Fork. The Gros Ventre River is a relatively large tributary, collecting runoff from a little over 25 percent of the total drainage area above the U.S. Geological Survey (USGS) gage site, Snake River below Flat Creek. It enters the Snake River from the east within Federal levee project limits several miles upstream from the Jackson-Wilson Bridge. Fish, Flat, Mosquito, Cottonwood, Taylor, Squaw, and Spring Creeks are among the smaller tributaries that enter the Snake River in the vicinity of the four study areas. Flat Creek enters the Snake River at the downstream end of the valley just below the Highway 26 Bridge.

The Snake River and its tributaries in the upper Snake River Basin have regular patterns of natural seasonal flow with high flows during the months of May through July, receding flows in August and September, and low flows in the months of October through April. High flows in the late spring and early summer result from melting of the winter-accumulated snowpack, sometimes augmented by rainstorms. Winter flooding due to thawing conditions and rain-on-snow conditions can occur, but rarely result in damaging flows. For the period of record, maximum annual peak discharges have always coincided with the spring snowmelt season. Total annual runoffs for a given area vary with the amounts of precipitation received during the snowpack accumulation and the snowmelt season

Regulation of water levels by the use of storage space in Jackson Lake reduces the Snake River flow during October through May and early June and augments Snake River natural flows during July, August, and September in order to satisfy downstream irrigation requirements. Further coordination with the U.S. Bureau of Reclamation (USBR) regarding the regulation of Jackson Lake could result in enhancement of environmental benefits presented in this *Feasibility Study*.

2. EXISTING PROJECTS, PRIOR STUDIES, AND REPORTS

2.1 Existing Flood Control Levees

The original design of the Jackson Hole Federal Levee System provided for approximately 23 miles of continuous, revetted levee along the Snake River. The Federal levee project begins 4 miles below the Snake River Bridge near Moose, Wyoming, and ends about 4 miles below the Jackson-Wilson Bridge (Plate 5). The Federal levees were completed in 1964. Over the years, many post-project levees, commonly referred to as the "non-Federal levees," were constructed outside the limits of the Federal levee project. Each non-Federal levee was intended to solve problems for localized areas. Various Federal, State, and local agencies, sometimes with private assistance, constructed these levees. The non-Federal levees include a continuous set of levees on the Gros Ventre River downstream of the Grand Teton National Park boundary and a number of discontinuous levees on the Snake River downstream of the Federal project levees. Most of the Snake River non-Federal levees are along a reach that extends 9 miles from the end of the Federal project downstream to the U.S. Highway 26 Bridge. One non-Federal levee (95 Ranch) is located on the left bank just upstream of the Federal levees.

2.1.1 Federal Levees

With the enactment of the WRDA 86, these levees are now part of the Federal levee project, and the U.S. Army Corps of Engineers, Walla Walla District (Walla Walla District) has O&M responsibility for all of the Jackson Hole levees. The Federal/non-Federal terminology is retained in this report because it has been used in the numerous prior Jackson Hole studies and is familiar to local interests. The original Federal levee system extends from river mile (RM) 961.0 to RM 947.6 on the right bank of the Snake River. On the left bank, the levees begin at RM 961.8 and end at RM 947.6, with a break between RM 957.2 and RM 952.8. The break is in the vicinity of the Gros Ventre confluence in a reach with narrow floodplains left of the main channel. Levees were aligned to follow the edge of the main channel with slight setbacks to avoid underwater excavation of the riprap toe trench. The alignments were then smoothed to reduce direct impingement of the river as the main channel meanders between the levees. The gap between the levees is about 1,000 to 1,600 feet, compared to the natural active meander belt

width of 1,000 to 4,000 feet. The separation was designed to restrict the river enough during flood flows to reduce debris accumulation and log jams.

The cross-sectional profile of the levee consists of a lower, toed-in, riprapped portion with a 1 vertical on 2 horizontal slope and an upper cobbled portion with a 1 vertical on 4 horizontal slope (see Plate 6). The levee was designed to contain floods of 45,000 cubic feet per second (cfs) below the mouth of the Gros Ventre River and 37,000 cfs above the confluence. Three feet of freeboard was added to the computed water-surface profile to arrive at a top-of-levee design height. Above the confluence, the design elevations for the revetments were set at an equivalent flow height, about 4 feet below the computed profile for the standard project design flood. Recent hydraulic analysis has cast doubt on the ability of the present levee to pass the original design flow.

2.1.2 Non-Federal Levees

The Corps constructed many of the non-Federal levees along the Snake and Gros Ventre rivers in Teton County during emergency flood fight operations (see Plate 5). These levees supplemented the flood control efforts of Teton County agencies. The U.S. Soil Conservation Service, the Wyoming Department of Transportation, the Wyoming Game and Fish Department (WGFD), and Teton County constructed other levees. Projects constructed under Federal emergency disaster assistance authorities, such as PL 84-99 or PL 93-228, are categorized as non-Federal unless they were constructed as a replacement for a damaged Federal project. Such emergency projects were not necessarily constructed to the design standards imposed on Federal project levees.

Large sections of the non-Federal levees were intended primarily to protect the river bank, while other segments tend to limit the channel's natural migration. Portions of the levees also act as channel plugs to prevent floodwater from flowing into certain side channels. Riprap protection was included in construction of segments that needed to resist direct impingement and erosion. Subsequently, additional segments were revetted when the main channel shifted closer to the offset levee portions.

2.2 Prior Studies and Reports

The Snake River and tributaries in the vicinity of Jackson, Wyoming, has been the subject of numerous water resource and environmental resources studies. Past efforts of interest to this *Feasibility Study* have been conducted by the Corps and other Federal, State, and local agencies. These studies have focused on issues ranging from flood protection, geological quarry investigations, environmental assessments, O&M of existing projects, project modifications for improvement of the environment, and fish and wildlife habitat restoration. A description of pertinent prior studies and reports follows.

2.2.1 Jackson Hole, Wyoming, Flood Damage Reduction and Fish and Wildlife Restoration Reconnaissance Study, June 1993

The *Jackson Hole, Wyoming, Flood Damage Reduction and Fish and Wildlife Restoration Reconnaissance Study* responded to two authorities: (1) The *Jackson Hole River and Wetland Restoration Study,* authorized by the U.S. Senate Committee on the Environment and Public Works to "mitigate for fish and wildlife impacts;" and (2) the *Snake River in Wyoming, Interim Upper Snake River and Tributaries Study*, authorized by the U.S. Senate Committee on Public Works to determine whether modification of the upper Snake River would be advisable.

This *Feasibility Study* also addresses both authorities in a combined study effort which allows a coherent and consistent formulation of the without-project scenario for the study area. This consistent picture of without-project conditions provides a common base to formulate alternatives addressing both authorized study purposes (*i.e.*, flood damage control, and fish and wildlife restoration). The comprehensive approach better serves the public while increasing overall management efficiency. The combined approach is also consistent with the *Position Paper*, issued August 14, 1992 by the Walla Walla District, developed with the Corps, North Pacific Division, and approved on October 21,1992 by Corps Headquarters (HQUSACE).

2.2.2 Snake River in Wyoming Interim, Upper Snake River and Tributaries Study (General Investigations)

The *Snake River in Wyoming Interim Study* was first initiated in 1961 in the *Joint Report Upper Snake River Basin*, 1961 by the Corps and the USBR. The *Interim Report No. 6, Lower Jackson*

Hole Channel Project was published in April 1965. In this report, the Corps identified improvements to be done in the 8 miles of the Snake River below the Federal levee project and recommended that the levee system be completed to the U.S. Highway 26 Bridge. In August 1986, Teton County requested that the interim study be resumed to evaluate opportunities for reducing flood damage for the whole levee system. A draft *Preliminary Report,* completed by the Corps in December 1988, recommended that detailed levee modification studies be undertaken. Congressional commitments originally called for submittal of an interim report by November 1988, but this report was delayed while the Corps evaluated the economic feasibility of O&M as mandated by WRDA 86.

The Corps elected to prepare a decision document because insufficient resources were available to complete a feasibility study document. The preliminary study resulted in a draft *General Investigations (GI) Decision Document* dated June 1990. This document recommended detailed studies for extending the left bank Federal levee above the mouth of the Gros Ventre River and raising the Gros Ventre River levees to the 100-year protection level. The draft GI Decision Document was never finalized because of anticipation of resuming the Snake River in Wyoming Interim Study. The Snake River in Wyoming Interim Study resumed in March 1992 with a scheduled completion date for the feasibility report and EIS in 1993. Under this study, improvements to the levee system were evaluated.

A NEPA scoping meeting was held in Jackson, Wyoming, on March 4, 1992 to elicit comments about the proposed levee improvements from the public. Many local groups urged the Corps to implement a comprehensive planning approach to the entire levee system and to consider the effects that individual projects may have on the rest of the system. The Corps received several letters from individual property owners, local officials, and various organizations. These people stated their concern with a piecemeal evaluation and requested that the EIS for the possible extension of the left bank Federal levee and raising of the Gros Ventre levees consider the whole levee system. This reconnaissance report, which combines all area studies into one comprehensive study, is in response to those requests.

2.2.3 Jackson Hole Restoration Study (General Investigations)

The EIS process for the May 1990 O&M EIS resulted in numerous requests for the Corps to mitigate for environmental effects of levee construction. Public input on this subject generally

stressed the national significance of the affected resources. As a result, the Jackson Hole Restoration Study was authorized in the Water Resources Development Act of 1990 (WRDA 90) and funded for fiscal year (FY) 91 to determine how levees affected fish and wildlife and to recommend short-term and long-term restoration. The reconnaissance phase study was initiated in March 1991.

The O&M EIS process resulted in a Section 7 consultation with the U.S. Fish and Wildlife Service or Fish and Wildlife Service (USFWS) on endangered species (bald eagles). The Corps agreed to use the Restoration Study to evaluate short-term measures for spring creeks improvements that might be implemented under O&M funding. Therefore, this reconnaissance study identified specific short-term recommendations for solutions to implement the Section 7 agreement with the USFWS. The Record of Decision, signed September 1990, requires the Corps to improve the spring creeks to benefit bald eagles. Also, as part of these short-term measures, culverts for fish passage were to be modified in FY 92 as agreed to under Section 7.

2.2.4 Jackson Hole Section 1135 Study (Continuing Authority Program)

Under Section 1135(b) of WRDA 86, a fish and wildlife restoration demonstration project was approved for implementation in the Jackson Hole area. The original legislation provided for implementation of demonstration projects during a 2-year period, beginning November 17, 1986. However, Section 307(d) WRDA 90 added the demonstration program to the Corps Continuing Authority Program, resulting in the removal of funding limitations of the original demonstration project allocation. The initial estimate was for a $480,000 island protection and spring creeks restoration project.

The project proposed for implementation under Section 1135 will provide information on spring creeks restoration design and costs. The Section 1135 is intended to serve as a prototype for identifying water relationships in the riparian zone between the river, groundwater, and surface waters behind the levee; and how these relationships directly relate to the larger feasibility study effort and the potential recommendations. This information is also needed to implement some of the objectives of the Section 7 agreement.

The draft *Detailed Project Report and Environmental Assessment (DPR/EA)* was completed in January 1992. The draft *DPR/EA* proposed protecting a wooded island and restoring flows to

some of the alluvial channels cut off by one segment of the levee system in the Jackson Hole area. On April 21, 1992, the island protection was deferred because of concern about downstream impacts that had not yet been evaluated. It was recommended that the island protection proposal be evaluated in a feasibility study that considers system-wide impacts and interrelationships.

2.2.5 Snake River at Spring Creek Section 205 Study (Continuing Authority Program)

Because of local problems of avulsion in the Spring Creek confluence area, Teton County requested a Section 205, small flood control project, study, which was initially approved by the Corps. This study was later deferred until comprehensive solutions (*i.e.*, this *Feasibility Study* along with the other flood damage reduction solutions at other sites in the area) could be evaluated.

2.2.6 Other Prior Studies and Reports

2.2.6.1 South Park National Elk Feedgrounds Section 205 Study (USACE, 1951)

A Section 205 *Detailed Project Report: South Park (Elk) Feedgrounds Location, Snake River, Wyoming*, dated September 5, 1951, recommended levee improvements to protect the Elk Feedgrounds. The Corps did not construct a project, but later the WGFD constructed a levee.

2.2.6.2 Upper Snake River Basin Study (USACE, BUREC, 1961)

A joint study of the upper Snake River Basin by the Corps and the USBR was completed in 1961. Corps participation was authorized under the Upper Snake River and Tributaries study authority. This study recommended extending the left bank Federal levee downstream to the U.S. Highway 26 Bridge, and a 0.6-mile section at the lower end of the right bank of the project where the current Evans Levee is located. Parts of the left bank levee were constructed over the years as the Federal Extension, Imenson, Spring Creek, Game and Fish, and South Park Levees. These were non-Federal intermittent levees.

2.2.6.3 Upper Snake River and Tributaries Study Interim Report No. 6 (USACE, 1965)

The *Upper Snake River and Tributaries Study, Interim Report No. 6, Lower Jackson Hole Channel Project, Snake River, Wyoming,* dated April 1965 recommended construction of levees on the sites of the current Sewell/Taylor Creek Levees and the Imenson Levees. The Sewell Levee was constructed by the Corps for the Soil Conservation Service in 1977, the Lower Taylor Creek Levee was constructed by the Corps in 1969 under Operation Foresight (PL 84-99), and the Imenson Levees were constructed from 1967 to 1971 under flood fight operations.

2.2.6.4 Sec. 208 Emergency Clearing and Snagging Study (USACE, 1968)

A Section 208 *Emergency Clearing and Snagging Project Report, Snake River, Wyoming, RM 955 to RM 965.5, Imenson Location,* dated October 4, 1968, recommended clearing and snagging this channel section under the Continuing Authority Program. This work resulted in an unrevetted setback levee referred to as the Upper Imenson.

2.2.6.5 Jackson Hole, Wyoming, Flood Protection Project Letter Report (USACE, 1988)

An unpublished draft Letter Report, completed in January 1988, looked at various alternatives for improving the levee system and the studies required evaluating these alternatives. This study was followed up by the O&M EIS. Limited clearing and snagging was completed in 1989 to remove snags from the river because the snags were affecting the levees.

2.2.6.6 Geological Reconnaissance and Quarry Investigation Reports (USACE, 1989, 1992)

A Geological Reconnaissance and Quarry Investigation Report was completed in April 1989 that located a number of potential quarry sites for riprap to maintain the levees under O&M authority. A second report prepared in December 1992, entitled *Jackson Hole, Wyoming, Geologic Investigations of Potential Quarry Sites* investigated in greater depth several of the potential quarry sites.

2.2.6.7 Hydrologic and Hydraulic Investigations Report (USACE, 1990)

A Hydrologic and Hydraulics Investigations Report was published in December 1990; it summarized the hydrological work completed to date on various studies in Jackson Hole. Additional sedimentation analysis information is included in this report as Appendix B, Hydrology.

3. WITHOUT-PROJECT CONDITIONS

3.1 Existing Conditions

An assessment of existing baseline conditions was conducted as part of the *Feasibility Study*. Categories of conditions evaluated include: Geology and Geomorphology, Hydrology and Hydraulics, Environmental Resources, and the Human Environment. The following pages provide summaries of the existing conditions assessment for each of these categories.

3.1.1 Geology and Geomorphology

Jackson Hole is an intermontane basin bounded on the west by the steeply sloping face of the Teton Mountain Range and on the east by the Gros Ventre Range. This basin was formed when a large block of the Earth's crust raised up along faults to form the Teton Range at the same time that the valley subsided (see Plate 7). Movement along the faults began during the formation of the Rocky Mountains approximately 9 million years ago and has continued to the present time. Pleistocene Epoch (approximately 3 million years ago) and recent movement along the Teton Fault, have been the dominant factors determining the positions of the streams on the floor of Jackson Hole, south of Jackson Lake. Large vertical displacements along the Teton and adjacent faults have exposed bedrock, primarily along the valley walls. As a result of Pleistocene glaciation, the valley floor is composed of a thick sequence of glacial sediments.

Large glaciers that advanced and retreated in the vicinity of Jackson Hole during the Pleistocene left behind a landscape abundant in glacial features. The Teton Range was carved by glacial ice, leaving behind high peaks, deep cirques, v-shaped canyons between the peaks, and moraine impounded lakes. The valley was the dumping ground for glacial debris as evidenced by numerous terminal and lateral moraines, not to mention the large blanket of material deposited on the valley floor. The present day stream morphology in the valley is generally referred to as a high energy braided system and is greatly influenced by the large amounts of glacially derived sediment that the streams must transport. The paths that the streams follow in the valley are, however, controlled by tectonic tilting of the bedrock beneath its thick sediment cover.

Downstream from the Gros Ventre confluence, several features suggest that the Snake River channel has been aggrading. These features include flat or convex valley cross sections, low or poorly defined channel banks, a wide meander belt, old channel scars indicating widespread shifting of the channel in the past, and tributary streams which turn abruptly on entering the valley and then flow parallel to the Snake River. Another contributing factor, that may possibly be influencing the parallel flow of tributary streams on the west side of the valley, is tectonic tilting of the Teton fault block. The gentle, but measurable, westward slope of the terrace surfaces, and the absence of alluvial fans along the western edge of the valley, suggest that tilting of the valley floor may still be in progress.

Some concern has been expressed that the river, if unrestrained, might suddenly shift westward into the lower Fish Creek Channel, permanently flooding the town of Wilson and surrounding developments. However, it could be argued that the river would have escaped its present channel and become permanently trapped against the eastern toe of the Tetons long ago if tilting were the predominant influence. The river has, in fact, overflowed into these areas during past floods. However, any sudden changes in the slope of the valley floor, resulting from earthquake activity, could result in major changes in the path of the Snake River. The Jackson Hole area is considered to be a highly active region.

3.1.2 Hydrology/Hydraulics

The existing condition assessment for hydrology and hydraulics is summarized below in the following sections: Precipitation, Runoff and Peak Discharges, Water-Surface Profiles, Erosion and Sedimentation, Flooding, Existing Levee System, Jackson Dam Operations, and Groundwater.

3.1.2.1 Precipitation

The average annual precipitation varies from about 16 inches at Jackson to about 60 inches near the summit of the Teton Mountain Range. Minimum and maximum annual precipitation totals vary from about 60 percent to 150 percent of the mean annual precipitation, respectively. The 6-hour maximum rainfall for the 100-year storm is in the range of 2 inches $\pm$0.5 inch, and the 24-hour maximum rainfall is in the range of 3 inches $\pm$1 inch.

Precipitation is rather evenly distributed throughout the year in the valley, but more concentrated at higher elevations in the winter. Due to the cool temperatures of this high-elevation area, the precipitation accumulates mainly as snow from October through May. Average annual snowfall varies from about 80 inches at Jackson to over 300 inches at high mountain snow courses. Maximum annual snow depths vary from about 2 feet to over 10 feet, depending on the location. Maximum depletion rates of snow normally occur during May and June, often resulting in flood conditions on the Snake River.

There are approximately six climatological stations in the Basin with long-term records. Currently, the National Weather Service (NWS) maintains 10 climate stations providing daily readings in the Snake River drainage above Alpine and perhaps a dozen stations providing similar climatic measurements in nearby basins. The Natural Resource Conservation Service maintains seven Sno-Tel stations in the upper Snake River Basin above Palisades Reservoir providing real-time snow water equivalent readings and limited temperature and precipitation information. As with the climatological stations there are numerous additional stations in nearby basins that have good correlation with the Snake River sites. The Natural Resource Conservation Service also coordinates and publishes semimonthly snow course measurements for 17 stations in the Snake River Basin above Palisades. About nine snow courses have long-term records, some of which are used by various agencies in conjunction with precipitation measurements in computing spring runoff forecasts. Representative climatological and snow course information is given in Appendix B, Hydrology.

3.1.2.2 Runoff and Peak Discharges

The Snake River and its tributaries in the upper Snake River Basin have regular patterns of natural seasonal flow with high flows during the months of May through July, receding flows in August and September, and low flows in the months of October through April. A summary hydrograph for the USGS gage, Snake River Below Flat Creek, is shown on Plate 8. High flows in the late spring and early summer result from melting of the winter-accumulated snowpack, sometimes augmented by rain storms. Winter flooding due to thawing conditions and rain-on-snow conditions can occur, but rarely results in damaging flows. For the period of record, maximum annual peak discharges have always coincided with the spring snowmelt season and sometimes persist for days or weeks. Total annual runoffs for a given area vary with the amounts of precipitation received during the snowpack accumulation and the snowmelt seasons.

Summer thunderstorms are common in the mountains. However, runoff from these storms tends to be highly localized, and Teton County authorities report that storm runoffs do not approach damaging levels.

The annual pattern of discharge in the Snake River (and the study reach) is substantially modified by the storage and release of water for irrigation from Jackson Dam, which forms Jackson Lake. Regulation by the use of storage space in the lake reduces the Snake River flow from October through early June. Corresponding to the peak irrigation season, high flows are released into the river from July to September. Sustained flows during the summer sometimes exceed 11,000 cfs, which approximates natural (pre-levee) bankfull discharge conditions. Regulation by Jackson Lake Dam is discussed in greater detail in Section 3.1.2.7 of this report.

The primary source for stream flow records is the USGS. Plate 9 depicts the current USGS hydrological reporting network in the upper Snake River Basin, with the study reach called out just downstream of the Gros Ventre River confluence. In addition to the USGS published discharge data at various gage stations, inflow and release data is available from the USBR for the Jackson Dam and Palisades Dam projects. The stations within the vicinity of the project reach are listed in Table 3.1.

Table 3.1 - USGS Stream Gaging Records

Station Name	Description	River Mile	Station #	Drainage Area	Period of Record	Extremes (Daily Flow)
Snake River Near Moran, WY (1)	1,000 feet downstream from Jackson Lake Dam 4.1 miles west of Moran	988.7	13,011,000	807 sm	1903-present	Max 15,100 cfs June 12, 1918 (2) Min 0.30 cfs Oct. 28, 1969
Snake River Near Wilson, WY (1)		951		2,500 sm (3)	1972-1975	
Snake River Below Flat Creek, Near Jackson, WY (1)	1 mile downstream from Flat Creek 4.8 miles upstream from Hoback	938.9	13,018,750	2,627 sm	1975-present	Max 30, 200 cfs June 11, 1997 Min 690 cfs Jan. 19, 1988.
Snake River Above Palisades Reservoir, Near Alpine, WY (1)	0.3 miles downstream from Wolf Creek 6.4 miles upstream from Greys River, 7.4 miles east of Alpine 16.1 miles upstream from Palisades	917.5	13,022,500	3,465 sm	1937-1939 1953-present	Max 38,600 cfs June 11, 1997 Min 740 cfs Nov. 16, 1955
Snake River At Moose, WY (1)	0.2 miles east of Grand Teton National Park Headquarters Visitor Center at Moose 0.3 miles west of U.S. Highway 191		13,013,650	Not Determined	1995-present	
Gros Ventre River At Zenith, WY	0.5 miles southwest of Jackson Hole Country Club 5.5 miles north of Jackson, WY		13,015,000	683 sm	1917-1918 (monthly) 1987-present	Max 6,170 cfs June 6, 1997 Zero flow on many days Affected by diversion

(1) Gage is regulated by Jackson Lake.
(2) June 1894 was considerable higher.
(3) Estimated by Walla Walla District.

The USGS gage designated Snake River Near Wilson, Wyoming, was operated for 3 years during the period October 1972 to September 1975. The gage was located near the Jackson-Wilson Bridge at RM 951. Given its location relative to the Federal levee system, the station period of record has been extended through correlation with other nearby gaging locations to cover the entire period 1904 to the present. A correlation for the 1894 historical peak was also determined. Various drainage areas for the Wilson gage have been published over the years. The USGS determined the drainage area to be 2,342 square miles and carried this value in their annual stream flow listings. Based on this value, one can also determine that the Snake River

above the Gros Ventre River confluence has a drainage area of about 1,700 square miles. However, the Walla Walla District and other agencies had approximated the drainage area for the Wilson gage at 2,500 square miles prior to the 1970's. Based on the 2,500 square miles value, the Snake River drainage area above the Gros Ventre River confluence was determined as 1,878 square miles.

Due to the convenient location of the Snake River Near Wilson USGS gage, both regulated and unregulated annual peak discharges have been determined for this station for the period from 1904 until the Wilson gage was established in 1972. Unregulated (natural) peaks were computed by determining what the flood peaks would have been naturally without flood control operations and irrigation storage at Jackson Lake. For years when the gage was not operated, estimations of regulated peak discharges were made based on the records of relatively nearby USGS gaging stations, and from estimated or gaged spot flow measurements on tributary streams.

The Wilson gage was discontinued in 1975, and a new gage was established about 13 miles downstream at a location below Flat Creek where channel geometry was more stable. Although there are a number of small tributaries entering the Snake River downstream, including Flat Creek, the peak flow data from the new gage location has generally been used, without adjustment, for the Wilson area. In addition to the computed period of record (1904 to present), an estimate of the 1894 flood peak was made for the Wilson location based on correlation with records for the Snake River at Idaho Falls, Idaho, gage location. The 1894 flood was the largest in recent history for streams in the Northwest, disregarding the 1927 flood resulting from the Lower Slide Lake failure.

In summary, the flows in the study area were based on a composite record developed using correlation with other gages from 1904 through1972, the actual record at Wilson from 1972 through 1975, and the actual record below Flat Creek from 1975 to the present. Floods exceeding 10,000 cfs occurred 83 times between 1904 and 1988, and discharges exceeding 20,000 cfs have occurred 15 times. Major floods resulting from normal snowmelt are indicated in Table 3.2 (estimated annual peak discharges).

Table 3.2 - Major Flood Peaks for Composite Record at Wilson, WY			
Year	**Peak Flow (cfs)**	**Year**	**Peak Flow (cfs)**
1894	41,000	1927	22,900 (1)
1918	32,500 (1)	1943	22,800 (1)
1997	32,000 (2)	1911	21,900 (1)
1904	28,500	1982	21,800 (1)
1909	25,900 (1)	1913	21,200 (1)
1986	25,600 (1)	1914	20,700 (1)
1996	24,800 (1)	1928	20,700 (1)
1917	23,400 (1)	1912	20,200 (1)

(1) Flows partially regulated by Jackson Lake Dam.
(2) An unofficial reading of 32,027 was observed on this date. The official USGS data lists only the mean daily value of 30,200 cfs.

The Snake River frequency curves at Wilson, Wyoming were previously analyzed by the Walla Walla District in 1975. The additional data now available has been added to the previous data in computing new curves used for the current *Feasibility Study*. The approach applied to the analyses of the unregulated (natural) discharge frequency curves is similar in both instances. The present analysis was based on 83 years of systematic recording (1904-87) extended to include the 1894 historical peak (41,000 cfs). A log Pearson Type III curve was fit to the data using an adopted skew coefficient of -0.2. Only the regulated peak discharge frequencies were recalculated in 1987 for the Snake River study reach above the Gros Ventre confluence. Peak flood discharges for selected recurrence intervals at this and other locations are listed in tabular form on Table 3.3

Table 3.3 - Natural and Regulated Discharge- Frequency Relations						
Exceedance Probability	Average Recurrence Interval (years)	Snake River Above Gros Ventre (1)		Gros Ventre Near Kelly (2)	Snake River Near Jackson (3)	
		Natural (cfs)	Regulated (cfs)	Natural (cfs)	Natural (cfs)	Regulated (cfs)
50	2	15,700	12,000	2,900	19,700	14,600
20	5	20,200	15,300	3,90	25,200	18,800
10	10	22,900	17,200	4,600	28,600	21,300
4	25	26,200	19,500	5,400	32,600	24,400
2	50	28,400	21,200	6,000	35,500	26,700
1	100	30,500	22,900	6,600	38,200	28,600
0.2	500	36,600	36,600	7,900	44,300	44,300

(1) Natural peak flow data for the Snake River above the Gros Ventre River confluence is derived form Walla Walla District frequency curves dated February 1975. Regulated peak flow data is derived from Walla Walla District frequency curve data dated July 1987.
(2) Natural peak flow data for the Gros Ventre River near Kelly is derived form Walla Walla District frequency curves dated September 1986.
(3) Natural and regulated peak flow data for the Snake River below the Gros Ventre River confluence is derived form Walla Walla District frequency curves data dated June 1987.

3.1.2.3 Water-Surface Profiles

Hydraulic modeling of the Snake River in each of the four selected study areas was performed using HEC-2, a computer backwater model developed by the U.S. Army Hydrological Engineering Center (HEC). Most of the proposed channel modifications would fall within the regulatory floodway as delineated by the Federal Emergency Management Agency in their May 4, 1989 Teton County Flood Insurance Study. The area is designated as a no-rise area which means that actions within or adjacent to the floodway should not result in a rise in the regulatory, 100-year floodwater-surface profile.

Mathematical modeling of this river is very difficult. The flow pattern is braided; the channel bed is constantly changing; and the river does not flow in the same channel from year to year. Gravel bars and accumulations of debris can cause local variations in the water surface. At certain levels, a very small change in the trial water surface results in a very large change in the surface area covered by the water. Due to these and other similar problems, a high degree of reliance should not be placed on the results of the mathematical analysis. Discrepancies of up to 2 feet can be expected in some areas, and a difference of up to 4 feet has occasionally been found

in areas where major channel changes have occurred or where divided flow exists. Since the river is constantly changing, the modeling results represent, at best, conditions at one point in time.

The model was calibrated to high-water marks, which were observed during the 1997 peak flood. During the 1997 flood, a peak flow of 32,027 cfs was observed at the USGS gage Snake River below Flat Creek. The results of the hydraulic analysis at each alternative site are indicated in Appendix B, Hydrology. Considering the aforementioned limitations, the HEC-2 models provided a reasonably good fit to the observed high-water marks and a thus provide a usable base for comparing the effects of proposed alternatives on the flood elevations.

3.1.2.4 Erosion and Sedimentation

Flow velocities in both the main channels and the secondary channels of the Snake River tend to be high, due to the general steepness of the valley. As a result the channel-bed complex is constantly changing. During high flows, avulsion of the main channel into side channels is common. When the flow erodes a gravel bar or the main channel becomes clogged with debris, the flow can shift direction suddenly and unpredictably.

Construction of the Federal and non-Federal levees along the Snake River blocked the lateral spread of the river and reduced the width of the floodplain and the degree of randomness of the braided system. This limited the ability of the channel to migrate and restricted avulsion activity to the area between the levees, concentrating flows in the existing main channels and increasing the frequency of attack on islands and vegetation between the levees. Bedload materials, brought into suspension by the turbulent flow, are more likely to be carried through the system rather than to be carried laterally into the slower secondary channels where they could be redeposited over a wider area of the floodplain.

Historical channel changes and erosion that has occurred in the past, were documented based on available aerial photographs of the area, some dating back to 1944. Photographs were reproduced at the same scale and overlaid to produce a record of the progressive erosion of vegetated islands and shoreline between 1944 and the present (Appendix B, Hydrology). Based on the photographs it was also possible to roughly estimate changes in the active meander belt area and channel length. The analysis provided information on erosional trends, level of

instability of each area, characteristic overflow routes, and meander magnitude and length. The photographs generally indicate that the vegetated islands have been progressively reduced in size or eliminated altogether between 1945 and the present. In their place, the river has left a broad active channel confined between the levees in which the bedload is constantly reworked. This constant churning has removed the finer material and thus leaves behind a bed that is predominantly in the gravel and cobble classes [2 millimeters (mm) through 256 mm] In parts of the study reach, half the bedload is in the cobble range (64 mm or 2.5 inches and above).

Historical bed elevation changes were determined for a 33-year period (1954-88) based on a series of sediment ranges (surveyed cross sections) established throughout the Federal leveed reach. The ranges were surveyed in 1954, 1967, 1973, and 1988. The vertical change in the thalweg and the average vertical bed change in the bed were determined along a larger reach that includes the study reach. Detailed results are shown in Appendix B, Hydrology.

Over the period of measurement, the surveys revealed a pattern in which areas of aggradation and degradation tended to be the opposite in several critical areas such as near the upstream and downstream ends of the levees and upstream of the Jackson-Wilson Bridge and the Gros Ventre confluence. The final 15-year period (1973-88) again exhibited a tendency toward alternate areas of erosion and degradation in a pattern nearly opposite to the previous period. Alternating areas of erosion and deposition are probably characteristic of the random nature of the process in a braided stream. Over-plots of successive range surveys indicate that a considerable amount of material was moved laterally during major channel shifts. A large part of the material eroded at one loop in the river was probably redeposited as a point bar on the inside of the next loop downstream. The average of erosion and deposition from 1954 through 1988 is shown in Plate 10.

The net volume of erosion during the 33-year period was heavily influenced by greater erosion in the early years (1954-67) following the completion of the levees. To an unknown extent, material borrowed from the riverbed during levee construction also contributed to the calculated losses. In the periods between 1967 through1973, and 1973 through 1988, losses tapered off gradually and then dropped off sharply. Measurements from more recent (and more limited) surveys taken in 1996 indicate that considerable sediment movement has occurred since the last complete survey in 1988. In Area 10, for instance, the 1996 survey indicated that more than 400,000 cubic yards of material may have been lost in this area alone since 1988. The flood of

1997, which peaked at the highest flow since 1918, probably moved a considerable amount of gravel and rearranged the channel-bed geometry.

Comparison of post-levee profiles and pre-levee profiles indicates that the greatest erosion has occurred where the levees had the greatest impact on the pre-project flow patterns during flood conditions. For instance, the area of deposition upstream of the Gros Ventre River corresponds to an area where no levees exist on the left side of the river, and levees on the right generally follow the active meander boundary. Downstream of the Gros Ventre, where the heaviest erosion took place, levees crowd the river to the east cutting off about one-half of the active meander belt width.

Determination of the amount of sediment that is transported through the study reach on an average year and during a major flood event would have been useful information. Unfortunately sediment transport and deposition on this reach of the river is very complex and difficult to determine. During a major flood, the flow is spread across a braided channel system that may look more like the teeth of a saw than a typical channel section. Along the same cross section there may be one or more areas of flow concentration where velocities reaching 10 to 12 feet per second (fps). There are secondary currents that may be moving at 3 to 4 fps, and intermediate areas of shallow overflow, where velocities are anywhere from 0.5 to 3 fps. Sediment is likely to be eroded from one bar exposed to a high-velocity current, then be redeposited a short distance downstream where the flow escapes over the side of the channel. Local residents have reported watching the current shift from the levee on one side of the river to the levee on the other in a matter of hours.

As part of this *Feasibility Study*, attempts were made to estimate the quantity of sediment that could be transported by the river in an average year by first calculating the initial transport capacity, and then running an HEC-6 computer simulation for an extended period of time to determine the equilibrium transport rate. Widely varying values were calculated depending on the formula used and the reach of the river being used as a transport reach. Numerous runs were also made in an attempt to determine the pattern of erosion and deposition with and without the restoration features for a typical year and for a period of 6 years in the future. Although a reasonable pattern was achieved on some trials the model was far too unstable to be considered reliable.

Due to the complexity of the flow patterns and lack of confinement of the flow, it does not appear possible to accurately model the sediment transport of the study reach with a mathematical model. A two-dimensional model would reproduce the instantaneous velocity distribution better. However, due to the channel complexity, and major channel boundary changes, it is unlikely that it would be successful. Although considerable effort was expended on this portion of the study, the results of the mathematical analysis did not appear to be accurate enough to justify the time and space required to include them in this report. Experience obtained by monitoring the proposed project and observing the effect of various restoration measures will likely provide a much better indication of system response than could be obtained with any modeling effort.

3.1.2.5 Flooding

Flood characteristics of the Snake River are typical of a highly braided stream. Due to the high transport of bedload the channel-bed complex is constantly changing. During high flows, avulsion of the main channel into side channels is common. When the flow erodes a gravel bar or the main channel becomes clogged with debris, the flow can shift direction suddenly and unpredictably. Flow velocities in both the main channels and the back channels tend to be high due to the general steepness of the valley. Flood damages include water damage from inundation, loss of land due to bank erosion, and damage to levees due to erosion or undercutting. Before the levees were constructed, flood damages in unleveed reaches began at flows of 5,000 cfs and became significant as flows increased to the 8,000 cfs to 10,000 cfs range. With the current levee system in place, significant damage now begins in the non-Federal reaches with flows in the range of 11,000 cfs. However, bank materials are often so low in resistance that erosion can continue, to some extent, even during low flows.

3.1.2.6 Existing Levee System

A system of levees was established in the lower reaches of the Snake and Gros Ventre Rivers to minimize flooding, confine lateral channel migration, and prevent bank, channel, and floodplain erosion (see Plate 5). The Federal project begins 4 miles below the Snake River Bridge near Moose, Wyoming, and ends about 4 miles below the Jackson-Wilson Bridge. Construction began in 1957 and was completed in 1964. Over the years, an array of non-Federal levees were

constructed outside of the limits of the Federal project, each to address a separate problem area. Construction was variously accomplished by local, State, and Federal agencies, sometimes with private assistance.

The federally constructed project provides continuous levees on the right bank of the Snake River between RM 961.0 and RM 947.6. On the left bank, the levees begin at RM 961.8 and end at RM 947.6, with a break between RM 957.2 and RM 952.8. The break is in the vicinity of the Gros Ventre confluence in a reach with a narrow floodplain left of the main channel, and includes Area 10. The levees act to: restrict lateral channel migration; confine floodwaters to a narrow, but relatively deep cross-sectional area; and reduce channel aggradation by improving movement of sediment load. The levees reduce the typical flooding zone within which channels migrate from 5,000 to 8,000 feet down to 1,000 to 2,000 feet. The levees are typically earthen and gravel fill constructs. The top width is 10 feet, the back slope is 2 to1, and the front slope is a combination slope with 2 to1 near the toe and 4 to 1 near the top (see Plate 6). The levee toe and the lower part of the front slope are protected by dumped stone up to a given flow level.

Many of the existing levees were constructed in response to perceived threats arising from avulsion of the main channel. As an example, there was great concern in the 1940's and 1950's that the Snake River was tending westward, posing a major threat to the town of Wilson and upstream developments. There has also been continuing concern that the river could eventually capture the lower reaches of Fish and Flat Creeks. Capture of Fish Creek is prevented as long as the Federal levees are adequately maintained. Capture of Flat Creek would harm the elk habitat area, damage spawning channels, and also endanger the Highway 26 Bridge. In the vicinity of the Gros Ventre River confluence, avulsion of both the Snake River and Gros Ventre River main channels is endangering spawning channels in the Three Channel Spring Creek study area. Bank erosion and channel scour was particularly evident following the 1986 flood. Extensive levee repairs were required during and after that flood, and, in addition, Teton County requested assistance for clearing and snagging operations in the main channels of both the Snake and the Gros Ventre Rivers. In response, a Federally funded, low-level clearing and snagging project was completed in the fall of 1989.

HEC-2 modeling accomplished for previous floodplain studies have indicated that flow velocities, averaged across the channel, during 100-year flood events vary from 2 to 11 feet per second (fps) on the Snake River studied reaches and from 4 to 9 fps on the Gros Ventre River studied reaches. Field observers have noted that local velocities were much higher at points

affected by log jams, flow over riffles and rapids, and at levee impingement points. The majority of the damage to the levee sections often appears to occur during the recession from the flow peak. It is likely that high flows, which override the gravel bars and low-flow meander loops, leave the channel bed clogged with debris and gravel. As the water level drops, the flow follows the path of least resistance where it may be directed against undisturbed land along the bankline. The flow may back up on one side of the channel, then flow rapidly down a steep incline toward the opposite side of the channel. These impinging flows can reach very high velocities, undermining trees, damaging or undercutting levee protection, and resulting in high levels of bank erosion in non-leveed reaches.

Velocity profiles taken during the May-June 1974 flood event (discharge of 13,790 cfs) estimated that high intensity impingement flows (of up to 10 fps) affected on the order of 5 to 10 percent of the Federal project levee length. During the 1991 runoff season the Corps Waterways Experiment Station collected water-surface profile data and measured impinging velocities at 8 different locations within the Federal project reach. Flows during this period varied from 14,000 to 16,000 cfs, which correspond to a 2- to 3-year peak flow event. It should be noted that the high velocities resulted from the flow escaping from a high point on one side and then accelerating across the channel to a low point on the other, where it impinged on the levee embankment. Results indicated that depth-averaged velocities could reach 12 fps in the impingement zone near the levees, and point velocities farther out could occasionally reach 16 fps. Velocities of 8 to 10 fps within 2 or 3 feet of the riprap face were very common at impingement locations. Scour depths of up to 15 feet below the water surface were measured in some locations.

3.1.2.7 Jackson Dam Operation

Nearly all of the large natural lakes in the area were formed behind the terminal moraines left by prehistoric glaciers. Jackson Lake, located on the Snake River 38 miles upstream from the city of Jackson, is, by far, the largest of these natural bodies of water, with a volume of 847,000 acre-feet, a depth of over 400 feet, and a length of 20 miles. Outwash from the large glacier at the Jackson Lake location, smaller nearby glaciers, and sediment from tributary streams is distributed downstream, forming a steeply sloping valley floor. Variations in vegetation, as seen on aerial photographs downstream of Jackson Dam, clearly show the patterns of a highly-braided flow that probably extended across the entire width of the valley during glacial recession.

Similar patterns can still be seen in outwash from receding glaciers in the Columbia Icefields of Canada.

Outflow from Jackson Lake escapes around the eastern side of the terminal moraine at the present location of Jackson Dam. Episodes of meander belt widening and channel down-cutting have left several terrace levels stepping down to the present active channel bed. The channel entrenchment reaches a maximum depth of about 160 feet near Deadman's Bar (about 16 miles downstream of Jackson Lake Dam). The depth of entrenchment decreases and the width of the floodplain increases as one moves farther downstream. Finally, somewhere in the vicinity of the Gros Ventre River, the terraces disappear and the channel emerges on the surface of the valley. Numerous relic channels and secondary branches can be seen in aerial photographs. These often become active during high-flow periods, allowing flood flows to escape the main Snake River channel and fan out across the valley floor.

Reservoir levels at Jackson Lake have been regulated to maintain optimum breeding and nursery conditions for recreational fisheries (*e.g.*, Mackinaw Lake Trout) to the exclusion of native river species downstream. This has usually meant holding the pool elevation constant from October 1, the end of irrigation season and approximately the middle of Mackinaw egg-laying season, until the eggs hatch in the spring. However, recognizing river cutthroat trout as an important resource, fisheries managers have determined that a minimum stream flow of 280 cfs from Jackson Lake is required to support a healthy population of river cutthroat trout. The optimum flow is 400 cfs, and flows above 600 cfs should be avoided. To implement this plan, the lake can be drawn down as much as 5 feet after October 1 to maintain stream flows below the dam. There is an attempt to meet the 280 cfs minimum, but no formal minimum release requirement exists. The USBR *Operations Manual*, dated December 1997, states in part: "If the reservoir was drawn down to the minimum flood control space on October 1 then the release is set to match inflow. If the reservoir was drawn down below the minimum flood control space on October 1 then the release can be set to a minimum of inflow or 280 cfs whichever is less. The release selected will allow the reservoir to either refill to the minimum flood control space gradually over the winter or refill as much as possible up to the minimum flood control space."

Without Jackson Lake Dam, flows would have dipped below 400 cfs in each of the last 87 years and dropped below 280 cfs in 74 of those years. Statistically, stream flows have been less than 400 cfs 21.1 percent of the time and below 280 cfs for 5.5 percent of the time. With Jackson Lake Dam in place, there were 9 years since 1909 with average annual flows less than 1,000 cfs.

The lowest year was 1977 with an average annual flow of 660 cfs. If flows above 4,000 cfs are excluded because they occurred during floods and may not have been held by a moderate size dam, then there were 15 years with average annual flows less than 1,000 cfs. Of these, 6 occurred as back-to-back pairs. Again, the lowest average annual flow was 660 cfs in 1977.

During the construction of Palisades Dam in 1956, the Corps negotiated 800,000 acre-feet of nonexclusive flood control storage at the two projects with 25 percent coming from Jackson Lake and 75 percent coming from Palisades Dam. The agreement requires the USBR to make the storage available between March 1 and May 1 each year unless the Corps and the USBR agree in advance that expected spring runoff would be better controlled by a different operation. Although snowmelt forecasting has come a long way, the exact timing and quantity of runoff is still subject to considerable error. The 1997 spring runoff was nearly 50 percent greater than anticipated, forcing both dams into defensive operation and causing severe flooding downstream.

For the current *Feasibility Study*, a representative sample of flow periods was selected that reflect current operating needs of downstream irrigators as interpreted by the USBR Reservoir Operations Center. Both 1992 and 1994 were classic low-flow years. The 5-year period extending from October 1991 through September 1996 appeared to provide a full range of possibilities including the 2 drought years of 1992 and 1994 as well as an unusually high runoff year in 1996. Assuming reasonable forecasting, volume becomes a more important indicator of low-flow capability than peak flow. Not surprisingly, irrigation demands are higher in low-flow years than in normal years due to dry conditions everywhere else in the basin. The basin runoff volume for 1994 was the sixth lowest flow on record, and followed only 1 year behind 1992, which was the fifth lowest flow on record. Being recent in history and very low, 1994 was chosen as the test case for low-flow discharge. Irrigation demands in 1992 were considered too extreme for the present analysis.

The HEC's model, HEC-5, Simulation of Flood Control and Conservation Systems, was used to route the flows through Jackson Lake. The following criteria were used for annual flow routing:

- Maintain a minimum flow of 400 cfs below the dam.
- Maintain minimum irrigation flows at Jackson-Wilson Bridge equal to 1994.
- Draw Jackson Lake down to elevation 6,755 by October 10.
- Do not exceed 15,000 cfs at Jackson-Wilson Bridge.
- Repeat the 1994 irrigation demand curve during each year of the simulation.

This analysis indicated that the 400-cfs minimum could be maintained during the winter if irrigation demand was the same each year. In the draught year of 1992 the irrigation demand was considerably higher than normal, resulting in an October 1 pool level that was several feet lower than would normally occur at this time of the year. It was so low that it would not have been possible to refill the reservoir if 400 cfs had been released during the fall and winter months. Based on the analysis to date, it appears that the 400 cfs could be maintained during normal flow years, but that during drought years similar to 1992, this level of release could not be achieved while still meeting the irrigation demands for the following year. It should be emphasized that the USBR operates Jackson Dam. They are in a better position to consider all of the operational constraints, and should be the agency that makes the final determination whether additional winter flow augmentation is possible

3.1.2.8 Groundwater

In addition to surface sources of water, considerable amounts of groundwater drain into the Snake River in Jackson Hole. The porous and unconsolidated alluvial and glacial deposits are the major aquifers in Teton County. Much of the floodplain is close to the level of the river and laced with abandoned or relief channels. Due to the ready exchange of water between the river and the aquifer, channels that have been abandoned or cut off by levees often still contain flowing or standing water. Along the Snake River and its major tributaries the aquifer can supply very large amounts of water. Water tables are often less than 5 feet below the ground surface for a significant portion of the year. Groundwater levels, reflecting the surface runoff patterns, are highest in the spring and early summer and lowest later in the fall and early winter. Local authorities and Walla Walla District construction personnel report that spring-fed water courses will rise in tandem with the snowmelt runoff in the main streams, but the increase in flow is of a much lesser magnitude and does not seem to approach damaging levels.

In the early 1990's concerns were raised by residents in the west bank area of the Snake River. At that time, there was basically no documentation of groundwater elevations in the area. The Wyoming State Engineers Office and the Teton County Commission initiated the Observation Well System north off Highway 22 and west of the Snake River channel that included 30 wells. Additionally, the Teton County Resource District through a cooperative arrangement with the USGS installed a surface water gaging system. The Wyoming State Engineer's Office, Surface Water Division installed a more expanded gaging system that monitored additional stream sites

as well as irrigation diversions. In 1997, the Wyoming State Engineer's Office, Ground Water Division, in cooperation with the Teton County Commission installed an additional 12 observation wells south of Highway 22 and west of the Snake River channel. This completed the system as it exists today with the exception of the 8 reference wells located along the east bank of the river, bringing the total number of wells up to 50.

Due to the infancy of the groundwater and surface water monitoring systems, there are no conclusions to be drawn at this point in the study. Appendix C, Groundwater, contains data that has been collected as part of a database that will be completed in the future. As the restoration effort continues, the existing monitoring system will prove to be a valuable tool for tracking what affects (if any) the restoration measures will have on the state of Wyoming water resource.

3.1.3 Environmental Resources

The existing conditions assessment of environmental resources are summarized below in the following sections: Aquatic Ecology, Terrestrial Ecology, and Threatened and Endangered Species.

3.1.3.1 Aquatic Ecology

The Snake River and tributary streams in the study area provide an environment for a wide variety of aquatic species including invertebrates, plants, and fish. Aquatic invertebrates are a major food source for all carnivorous fish in the Snake River and a wide variety including mayflies, true flies, caddisflies and stoneflies are present. Most are herbivores and detrivores although a few are carnivores.

True aquatic plant communities are supported by standing or flowing water year round and are composed of white buttercups (*Ranunculus* spp.), speedwell, waterweed, pondweed, and watercress. Mat-forming algae are common in shallow stagnant ponds, and liverwort and stonewart species are also common. The cobble-gravel bottom communities are dominated by foxtail, silverberry, willow, timothy, sedge, muhlenbergia, sweet clover, horsetail, and dock. Aquatic plants, particularly algae, supply a major food source to aquatic invertebrates and to primary consumers such as suckers.

The Snake River in much of the study area is designated as a Class 1 or blue-ribbon trout stream by the WGFD. This designation indicates that the river is of national importance as a trout stream and warrants the highest priority for protection. The fine-spotted cutthroat trout is the key aquatic species to be considered in the mitigation study and planning process. Among the many game and nongame fish species present in the region , the indigenous Snake River fine-spotted cutthroat trout is economically the most important species, as it is the major game fish captured by fishermen in the Snake River. The Snake River fine-spotted cutthroat trout is a self-sustaining (naturally reproducing) subspecies found only in the Snake River drainage from the Palisades Reservoir in Idaho, upstream to the headwaters in Yellowstone National Park. This wild stock maintains its current population by spawning in suitable habitat, regionally known as "spring creeks," without stocking of juvenile or adult fish to the river system. This trout supplies the major sport fishery in the Snake River, from Jackson Lake Dam down to the canyon area of the Snake River above Palisades Reservoir.

Spawning, rearing, and overwintering habitat are considered to be the major limiting factors for cutthroat trout in the study area. Most cutthroat trout spawning occurs during the period from March through June in the spring creeks that enter the river along the study reach. Openings to many of these spring creeks are currently blocked by levees. Little or no spawning habitat exists in the main river for a number of reasons. These include large sediment bedloads and turbidity in the springtime flows (during the spawning period), human induced modifications to the channel, and a cobble substrate that is typically too large for cutthroat spawning. Sloughs and side channels are important sources of rearing and overwintering habitat, particularly for young age classes of cutthroat trout.

Other trout species found in this region of the river are less abundant. They include brook, rainbow, brown, and lake trout (which may pass through Jackson Lake Dam), and possibly grayling.. Another game species that is apparently abundant but little utilized by fisherman is mountain whitefish. An increased amount of overwintering habitat would also be used by these species. The overall population distribution is not expected to change with features proposed in the *Feasibility Study*. Construction, maintenance, and long-term effects for these game fish species would be similar to the effects on cutthroat trout.

Nongame fish species present include suckers (an important food source for bald eagles), five species of the minnow family, with Utah suckers and Bonneville redside shiners most abundant,. and sculpins. Small fish may be used as prey by cutthroat trout.

Levee construction and other human activities have led to significant decreases in the amount and quality of spawning, rearing, and overwintering habitat for aquatic species . Increases in these resource types will be needed to promote the future viability of the game and nongame fish.

3.1.3.2 Terrestrial Ecology

a. <u>Vegetation</u>. The vegetation in the upper Snake River drainage near Jackson, Wyoming, is typical of the central Rocky Mountain region. Upland vegetation types in the area include sagebrush-grassland, lodgepole pine/Douglas fir, and subalpine fir/Engleman spruce . The sagebrush-grassland type occurs on the glacial outwash plains and terraces above the floodplain. This type is dominated by sagebrush and perennial grasses, *e.g.*, wheatgrasses, fescues, and bluegrasses. Forests dominated by lodgepole pine occur at lower elevations (6,300 to 7,800 feet) along rivers and above the glacial outwash plain. Douglas fir intermixes with lodgepole pine, but is generally dominant only on ridge tops and east-facing slopes. Subalpine fir and Engleman spruce dominate higher elevation (7,800 to 10,000 feet) forests.

The floodplain along the Snake River and its tributaries includes mixed deciduous/coniferous forests and wetlands. Floodplain forest consists of narrow-leaf cottonwood and willow intermixed with Engleman and blue spruce. Wetlands occur where the water table is high enough to support hydrophytic plants, *i.e.*, plant species that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. These include three major types: palustrine shrub-scrub, palustrine emergent, and aquatic bed. The palustrine shrub-scrub wetlands are found primarily on stable gravel bars and dikes and are dominated by willow and mountain alder. Sedges, cattails, and bulrush are the primary species in palustrine emergent wetlands. The dominant species in aquatic bed wetlands depend on bottom substrate. Aquatic beds along shorelines tend to support watercress. Pondweed is common in streams or ponds with silt bottoms and ballhead waterleaf occurs in rocky substrates.

The study area was once characterized by an abundance of diverse riparian vegetative habitats. Wooded islands, transitioning to riparian and wetland communities were a vital component of the highly productive braided-channel riverine environment. Construction of the levee system through most of the study reach has resulted in erosion, degradation, and in many cases destruction of these island habitats.

b. Mammals. The Jackson Hole, Wyoming, area is known for its diverse wildlife in the valley and surrounding mountains. Mammals such as elk, mule deer, moose, bighorn sheep, and American bison are the most prominent wildlife in the Jackson Hole area. Aquatic furbearers, black bear, wolf, coyote, and a variety of small and medium-sized mammals also occur. Big game concerns focus on usage patterns within the region of Jackson Hole. Important winter feeding areas are located near the work area and migration patterns to and from these feeding areas go through the Snake River drainage. The usage patterns include spring-summer-fall range, winter range, winter/year-long range, critical winter range, and critical winter/year-long range. The local mule deer, elk, moose, and bighorn sheep herds represent these types of usage.

Jackson Hole and the surrounding mountains provide about 1,000 square miles of summer range for approximately 15,000 elk. The National Elk Refuge to the northeast provides about 24,000 acres of winter habitat for 10,000 elk. The WGFD classifies this refuge as a crucial winter range, which is defined as one that determines whether the elk population in the area reproduces and maintains itself at or above WGFD target levels. The Jackson Hole area provides migratory habitat for mule deer throughout the year. The upper Snake River drainage provides year-round habitat for about 200 to 300 moose. During the winter, an additional 400 to 500 moose from the surrounding uplands migrate into the river bottom area. Bighorn sheep are present seasonally in all major drainages within the Snake River and Gros Ventre River Basins.

Smaller mammals including shrews and voles are common in riparian areas along the Snake River and its tributaries. Aquatic furbearers such as beaver, mink, and muskrat are commonly seen in streams, ponds, and backwater areas along the Snake River near Jackson, Wyoming. The levees are generally too rocky or exposed to provide habitat for either the beaver or muskrat. Additional species include the river otter and the hoary bat (both of which are considered rare in Wyoming), the silver-haired bat, and the long-eared myotis. The wolverine and lynx, also rare, occur in the region.

c. Birds. The upper Snake River drainage provides habitat for a wide variety of resident and migratory birds, including waterfowl, raptors, and passerines. Approximately 150 different species have been observed, and 119 are documented or expected to breed in the area. The wetlands, ponds, backwater, and tributary creeks in the Snake River floodplain provide habitat for waterfowl and waterbird spring/fall staging, breeding, nesting, brood rearing, and wintering. The most prominent birds include Canada geese, trumpeter swans (a candidate for Federal listing as threatened or endangered), and sandhill cranes. Detailed information on resident populations

of these birds is provided in the Environmental Assessment. Dabbling and diving ducks winter on the river between Moose Junction and South Park and between the Jackson-Wilson and South Park Bridges. Winter duck densities frequently average 139 per mile of river and tributary. Other birds known to commonly occur in the Snake River floodplain near the Jackson Hole area include the loggerhead shrike, black-backed woodpecker, killdeer, tree swallow, yellow-headed blackbird, common nighthawk, belted kingfisher, and Wilson's warbler.

d. Raptors. The high numbers of fish and small mammals provide prey for a variety of raptors. The most commonly observed raptors are eagles, falcons, osprey, hawks, and owls. Most nest in trees behind the levees.

e. Amphibians and Reptiles. Relatively little is known about amphibians and reptiles in the Jackson Hole area. Two frog species, the spotted frog, and northern leopard frog, and one toad species, the boreal western toad, considered very rare or rare in Wyoming, have been documented in the vicinity of the proposed restoration project areas. The sagebrush lizard and western terrestrial garter snake are probably two of the most common reptiles in the area. These two species could be present in the existing riparian vegetation within or near the proposed environmental restoration work.

3.1.3.3 Threatened and Endangered Species

Over 30 rare plant species tracked by the Wyoming Natural Diversity Database occur in the vicinity of Jackson Hole levees. None of these species are Federally listed or proposed as threatened or endangered, but three are protected on U.S. National Forest Service (USFS) lands. It is highly unlikely any of these species occur within the proposed restoration areas between the levees. The USFWS has documented five animal species in the Jackson Hole area that are classified as threatened or endangered. Endangered species observed in this area include the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), and peregrine falcon (*Falco peregrinus*). The Jackson Hole area is also within historical range for the grizzly bear (*Ursus arctos horribilis*), a threatened species, and gray wolf (*Canis lupus*), an endangered species.

a. Bald Eagle. The upper Snake River drainage provides year-round habitat for bald eagles. Nesting usually occurs between February 1 and August 15. The Snake River population unit,

which includes the Snake River in Wyoming, its tributaries, and Jackson Lake, consisted of 24 known breeding pairs in 1982. The Coordination Act Report received from the USFWS stated, "No work activity within 1 mile of any active nests would occur between February 1 and August 15." For this reason, work is only allowed within 1 mile of active nests (current year) between August 16 and January 31. Changes to this work window must have prior approval from the USFWS. Bald eagles are likely to be found in or near the proposed work area most of the year. The chances of the environmental restoration project having any impact on the bald eagle are minimal due to the timing of the active work. There would likely be no direct impacts (mortality, loss of nest, *etc.*) or long-term population impacts (reduced reproduction, *etc.*). There may be some minor displacement of foraging or roosting eagles.

b. <u>Peregrine Falcon</u>. Until recently, the peregrine falcon was considered extirpated from Wyoming. A recovery program was begun in 1980. Between 1980 and 1987, 153 peregrine falcons were released to hack sites (the term used for reintroduction sites) in Wyoming, primarily in Yellowstone National Park and in or near the National Elk Refuge. Approximately 80 to 83 percent of the released birds reached independence. The wetlands and streams along the Snake River south of the Jackson-Wilson Bridge support a variety of birds that are prey for peregrine falcons. This area is considered forage habitat for peregrine falcons and three to four adults and sub-adults have been observed in this region between 1982 and 1988. Peregrine falcons are expected to leave the area soon after nesting is complete. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August.

c. <u>Whooping Crane</u>. The whooping crane is one of the rarest birds in North America. Reintroduction efforts at Gray's Lake National Wildlife Refuge in Idaho have resulted in whooping cranes occupying habitat in western Wyoming since 1977. Whooping cranes are occasionally sighted in the Jackson Hole area, primarily along the Gros Ventre River, and do migrate through the area of Jackson Lake during early spring. There is a chance a whooping crane may stop along the river in the Jackson Hole area, especially if sandhill cranes are using the area.

d. <u>Grizzly Bear</u>. The historical range of the grizzly bear once included most of Western North America. Currently, only six areas in the United States, including Yellowstone and Grand Teton National Parks, support self-sustaining grizzly bear populations. The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area, however, current management in

Wyoming by WGFD is to discourage grizzly bears from living in areas of human habitation. The last sighting of grizzly bears in the Jackson Hole area was in 1994.

e. Gray Wolf. The gray wolf historically populated all habitats in the Northern Hemisphere except tropical rain forests and deserts. Currently, the largest populations of wolves in the lower 48 states occur in northern Minnesota. Remnant populations are believed to exist in Wyoming, Washington, Idaho, Montana, Michigan, and Wisconsin. In the summer of 1992, a wolf was sighted in Yellowstone National Park, the first documented observation in over 20 years. Wolves have been sighted this year following the elk herds into the Jackson Hole area (WGFD 1998, USFWS 1998).

3.1.4 Human Environment

This section describes the existing conditions in the study area related to population, land use, land ownership, socioeconomics, recreation, cultural resources, transportation, and irrigation.

3.1.4.1 Population

Jackson, Wyoming is the only incorporated town in the Teton County, and provides typical commercial, service, and public facilities, however there are several unincorporated communities and numerous suburban and rural residential neighborhoods in the area. Major employers in the county, varying with the season, include the Jackson Hole Mountain Ski Resort, Grand Teton Lodge Company, St. John's Hospital, Snow King Resort, Grand Targhee Ski Resort, Grand Teton National Park and the Teton County School District. The 1990 census indicated a population of 4,472 people in the town of Jackson and 11,172 in the county for a total population of 15,644 permanent residents. The official estimated 1997 population is 6,052 in town and 14,200 in the county for a total of 20,252. The seasonal resident population is considerably higher than this value, probably at least double.

3.1.4.2 Land Use

Land use in Teton County is heavily influenced by land ownership patterns. Federal land in the county is used primarily for recreation, wilderness, wildlife management, and forestry. Private

land is primarily classified as agricultural, although the use of land for agricultural purposes has diminished over the years. Over the past few decades, land previously classified as agricultural has been converted to residential and other nonagricultural uses. The Federal government is the largest landowner (97 percent) in Teton County.

Table 3.4 - Partial List of Land Use in Teton County

Agency	Description/Name	Area (acres)
U.S. Forest Service	Bridger-Teton National Forest	1,096,000
U.S. Forest Service	Targhee National Forest	276,000
U.S. Forest Service	Shoshone National Forest	2,000
National Park Service	Grand Teton National Park	310,000
U.S. Fish and Wildlife Service	National Elk Refuge	24,000
U.S. Bureau of Reclamation	Jackson Dam	N/A (not available)
U.S. Bureau of Reclamation	Snake River Vicinity	9,000
State of Wyoming	School Trust and Resource Lands	10,000
Wyoming Game and Fish	Wildlife Habitat	2,000
State Trust		8,000
Private Property		75,000

Private property accounts for approximately 3 percent (75,000 acres) of Teton County. And privately owned lands in the county are concentrated on the valley floor of Jackson Hole south of Grand Teton National Park. Most of the private lands within Jackson Hole have not been intensively developed, although there has been rural-to-urban land conversion over approximately the past 3 decades. Ranching has declined considerably as an economic activity, but much of the former ranch land remains mainly in agricultural or woodland use.

3.1.4.3 Socioeconomics

The Snake River and its tributaries have been an important resource in the economic and social development of the Jackson Hole area. A study of the economic importance of fishing to Jackson Hole is, in effect, a study of two of the states most outstanding resources: (1) the Snake River and its system of associated smaller rivers and creeks, and (2) the cutthroat trout. Fishing activities create demands for goods and services. The Jackson Hole area has become the summer home and vacation home destination for a number of families since 1970. Expenditures by these

families in the Jackson Hole area, like tourist expenditures, represent a new demand for goods and services and a flow of new money into the local economy.

Local jobs maintained by the $143,000,000 output related to sports fishing, accounts for about 25 percent of the total employment of Teton County. This is based on statistics furnished by the Jackson Hole Economic Development Council Web site. Local nonfarm sales in 1997 were estimated at $583,000,000 based on sales tax receipts of $35,000,000 in this sector. The sales tax rate of 6 percent would indicate gross sales of $583,000,000. Approximately 18,500 workers generated this $583,000,000 in sales. This allows each worker to generate $31,600 sales per year. If the $143,000,000 sports fishing output and sales is maintained, 4,500 jobs would be enhanced in the area.

3.1.4.4 Recreation

The Snake River in the vicinity of the four project areas principally experiences recreational use from rafting and fishing. Some waterfowl hunting also occurs on the river. Levees along the four project areas are used for a variety of recreational purposes including walking, hiking, jogging, bicycling, cross-country skiing, horseback riding, bird watching, nature viewing, picnicking, and other similar uses. The levees also provide access for direct river use such as fishing and waterfowl hunting.

The majority of recreational use within the study areas occurs in Area 9 near the Jackson-Wilson Bridge which carries Highway 22. Recreational use at this site occurs year-round, with high use continuing into November. South Park National Elk Feedgrounds receives limited public recreational use, most of which occurs during summer as hiking and nature viewing. However recent improvements in pathways near the Elk Feedgrounds have resulted in increases in public recreational use. The southwest levee at Jackson-Wilson Bridge experiences considerable use. The northwest levee gets only limited use while the southeast levee does not get any use. The northeast levee gets a lot of use due to the close proximity of a park. Many private lands along the river carry recreational easements granted to the U.S. Bureau of Land Management (BLM). In general, boating, wading, hiking, picnicking, *etc.* are allowed while shooting, hunting, open fires, and camping are not allowed on the private land easement areas. In addition, all BLM lands are closed to camping.

Views of the floodplain, by boaters and other recreationists using the Snake River, are generally restricted because of adjacent riverbanks, levees, and vegetation. The primary views along the rivers are of the mountains, particularly the Grand Teton Mountains, which can be viewed beyond the riverbanks and levees in locations where there are openings in the riparian vegetation.

3.1.4.5 Cultural Resources

The area of the proposed environmental restoration project includes floodplain areas between the levees along the Snake River. A Class 2 reconnaissance survey was performed within the generalized environmental restoration project study areas during the period August 12 to 16, 1996, by the Walla Walla District's staff archaeologist. Record searches were also conducted. No previously unrecorded cultural properties were found during the reconnaissance survey. Record searches identified two previously recorded sites close to two of the proposed environmental restoration project areas, but outside of the levees. Because the previously recorded sites are located outside of the levees, away from where the proposed actions would occur, the Corps determined that the proposed environmental restoration project would have no effect on any previously listed cultural property. The Corps also determined the potential for the occurrence of any unrecorded cultural properties in the areas of impact to be low.

A copy of the Corps' Survey Report was forwarded to the Wyoming Division of Cultural Resources, State Historic Preservation Office (SHPO), for review and concurrence. In their letter of February 12, 1997, the SHPO responded that no sites meeting the criteria of eligibility for the National Register of Historic Places would be affected by the environmental restoration project. The SHPO recommended the project proceed in accordance with state and Federal laws, subject to the following stipulation: "If any cultural materials are discovered during construction, work in the area should halt immediately and the Corps and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken."

3.1.4.6 Transportation

Several highway routes provide year-round transportation in the vicinity of the proposed environmental restoration project. The primary route used by north and southbound traffic is U.S. Highway 26 (Plates 1 through 4). The highway enters the Jackson Hole area from the northeast, continues through the valley and the community of Jackson and exits the valley to the south. Wyoming State Highway 22 starts on the west side of Jackson, crosses the Snake River at the Jackson-Wilson Bridge, and continues west over Teton Pass. Wyoming State Highway 390 extends north from its intersection with State Highway 22 near the Jackson-Wilson Bridge and is a primary route used by north and southbound traffic on the west side of the valley.

3.1.4.7 Irrigation

Numerous irrigation diversions exist off the Snake River and other major tributaries. Diversions can have significant impacts. As an example, during low water years, the total flow is diverted from the Gros Ventre River in late summer and fall, leaving the lower 3 miles down to the Snake River confluence dry, except for a small amount coming from groundwater springs and irrigation return flows.

The irrigation season generally lasts from about May 1 to October 1. There are currently eight active diversions within the Federal levee project area and an additional eight inactive diversions. Some of the diversion headworks serve more than one canal. The headworks are typically concrete with hand operated slide gates. Downstream of the Federal project levees, there is a major diversion behind the Upper Taylor Creek Levee, a major diversion through the Federal Levee Extension, and a minor diversion at the upstream State Game and Fish Levee. The two major diversions are for irrigation, and the minor one provides a dependable supply of water to a downstream spawning channel tributary to Flat Creek. There are no active diversions in the vicinity of the non-Federal levees along the lower reaches of the Gros Ventre River. However, there is a major diversion along the left bank of the Gros Ventre River just upstream of the Grand Teton National Park boundary. There is also a back channel on the right bank of the Gros Ventre River above the non-Federal levee area from which numerous diversions are made, including some into the country club and golf course developments.

Once Jackson Lake is filled by the spring runoff, Jackson Dam passes inflow. Releases above the level of inflow commence when required by those holding irrigation storage rights. In general, elevated flows last all summer and taper off to minimum releases in September or early October.

3.2 Future Without-Project Conditions

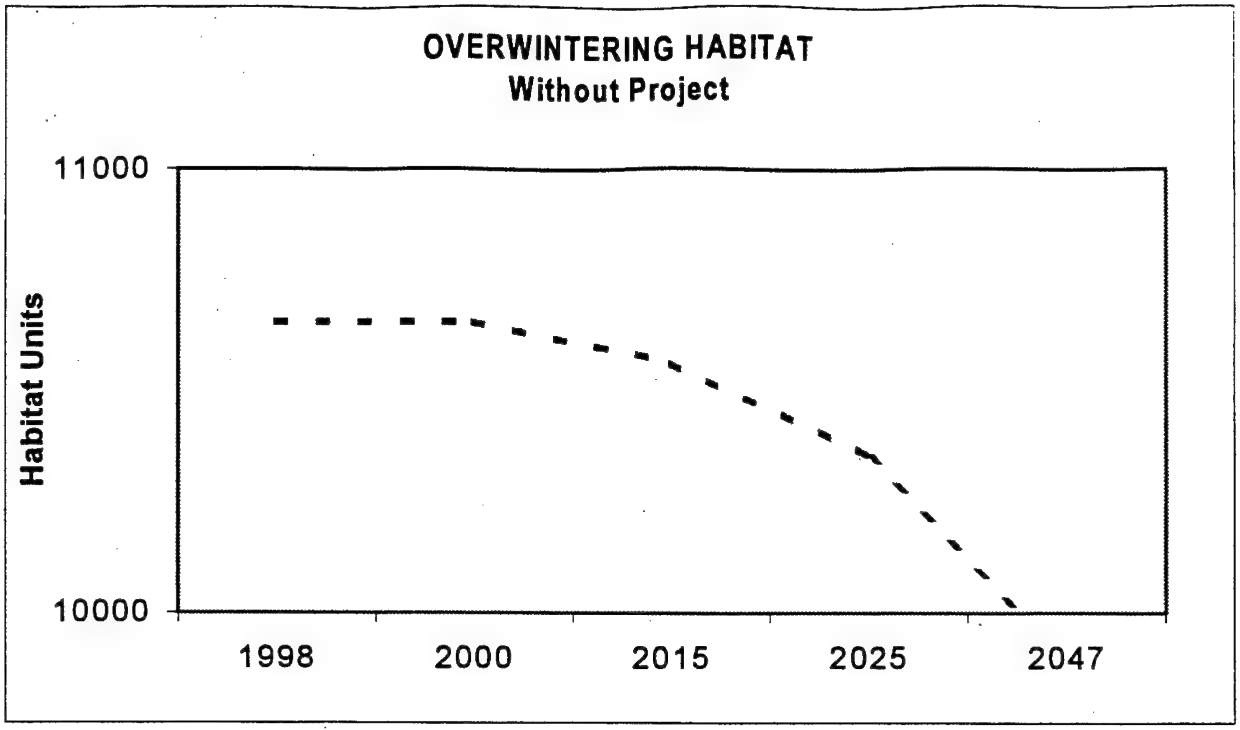
Resurveys of established sediment ranges within the Federal levee reach indicated a net loss of about 3 million cubic yards of material from the entire reach between 1954 and 1988. Most of the erosion occurred prior to 1967 during and immediately following levee construction. Since then, the degradation has tapered off as the channel has adjusted to the new regime. Recent sediment range resurveys covered a very limited length of the reach and are thus somewhat inconclusive. The available surveys downstream of the Federal levee system in Areas 1 and 4 are also somewhat inconclusive although there is some evidence of channel thalweg aggradation at some locations. In the future without-project condition it is expected that the channel (average section and thalweg) will continue to degrade overall at a progressively lesser rate in Areas 9 and 10 with possible continued aggradation in Areas 1 and 4.

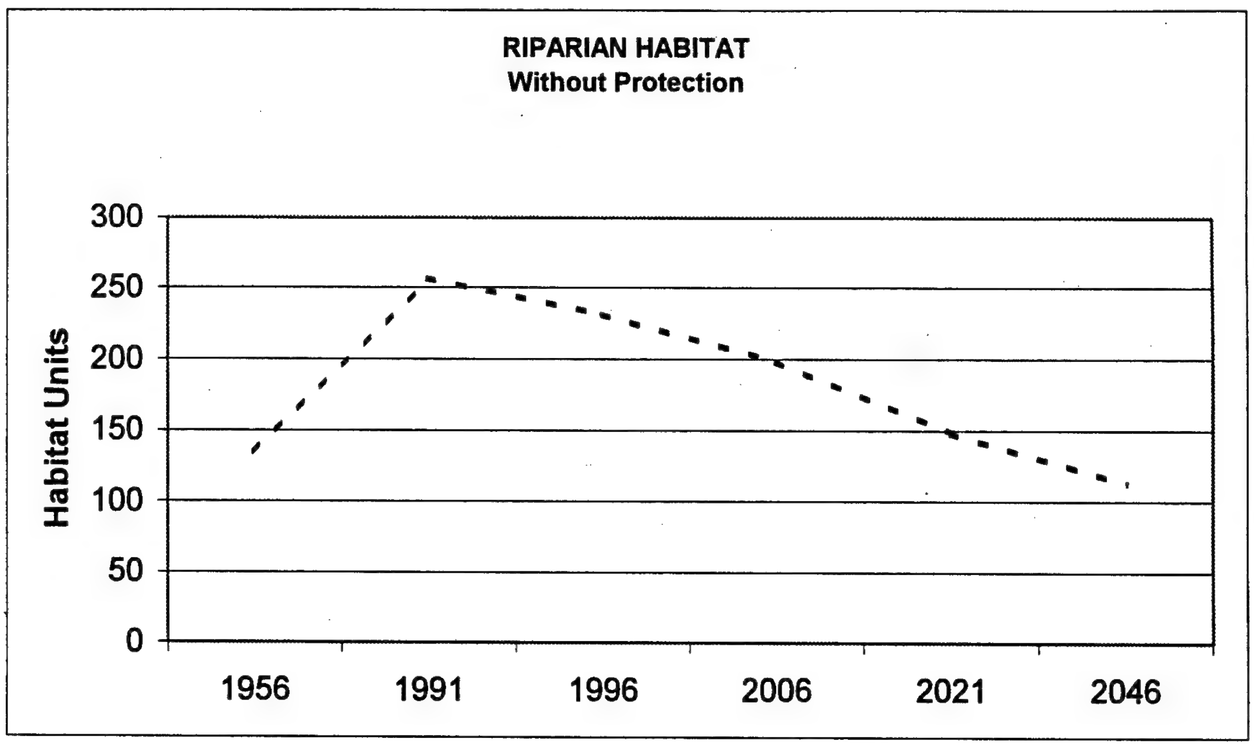
While the net erosion within the study reach may not be significant, localized changes in the channel bed will continue to dominate the river between the levees. In the future without-project condition, the Snake River will continue to form and plug new low-flow channels and braided systems between the levees. Previously observed patterns, including alternating and fluctuating zones of aggradation and degradation, are expected to continue. The problem of flow impingement on the existing levees and the associated cost of placing additional low-flow armor to protect them will also continue. This work is currently performed by the Corps, which is responsible for maintenance of the Federal levees.

The remaining in-channel islands will continue to be eroded, and the existing habitat will be lost. Any new islands that form between the levees will not be in place long enough to establish permanent aquatic and terrestrial habitat. The latter problem is compounded by the exceptionally coarse bed material, which makes plant establishment difficult.

3.2.1 Future Habitat Trends

Habitat analyses conducted as part of the feasibility study showed a future continued trend of riparian habitat destruction within the levees further promoting the shift from a highly diverse and productive ecological system to one where nearly all out-of-channel habitat is primarily gravel from levee to levee. The degradation in riparian habitats has pronounced impacts on both aquatic and terrestrial species. Aquatic habitat analyses conducted in this *Feasibility Study* showed that without intervention there would be a trend of continued significant habitat degradation, including the reduction of vital rearing and overwintering habitats. The following two figures display the trend of continued aquatic and riparian habitat degradation that was identified by the study's environmental modeling.


OVERWINTERING HABITAT
Without Project
Habitat Units
11000
10000
1998
2000
2015
2025
2047


RIPARIAN HABITAT
Without Protection
Habitat Units
300
250
200
150
100
50
0
1956
1991
1996
2006
2021
2046

4. PLAN FORMULATION

4.1 Problem Identification

In the 1950's, the Snake River near Jackson, Wyoming was a highly braided system with a broad floodplain and numerous vegetated islands (Plate 11). Over time, development of the Snake River levee system has created significant changes in physical processes that have resulted in the loss of valued environmental resources. The levees have reduced the cross section of the main channel and have effectively separated it from the floodplain (Plate 12). The resulting concentration of flows lead to a deeper, straighter channel (Plate 13) with higher velocity flows that have removed progressively larger sediment sizes. The overall cross section and thalweg have lowered and the remaining bed material, which is now mostly gravel and cobbles, is constantly reworked by low and high flows.

This constant shifting of the riverbed between the levees has eliminated the natural braiding of the river and has resulted in a number of negative effects. Foremost, it prevents reestablishment of stable islands with mature vegetative stands and associated riparian and aquatic habitat (see Plates 14 and 15). Second, low flows, especially during the recession of the hydrograph, have a tendency to run across the channel and impinge directly onto existing levees. The combinations of impingement, and locally aggrading areas within the riverbed (which locally raise the water-surface elevation) have necessitated construction of additional armor on the river side of the levees. Since the points of impingement can vary from flood to flood, the additional levee protection represents a high maintenance cost that will continue into the future. Finally, flows will continue to attack the few remaining islands as well as unprotected banks. The environmental consequences include a loss of diversity in aquatic, wetland, riparian, and terrestrial habitat as well as reduced value of remaining in-stream, riparian and terrestrial habitats.

4.2 Problems and Opportunities

Section 4.1 provided a general description of water-related environmental resource problems in the study area. The general source of these problems is *increased instability of the river channel*

as a result of flood control improvements that narrowed the historic floodplain. Specific problems that stem from this channel instability include: (1) system inability to establish and maintain sustainable, diverse riverine ecosystem habitats; (2) declining in-stream aquatic habitat (quantity and quality); (3) declining wetland and riparian habitats (quantity and quality); (4) declining habitats (quantity and quality) for sensitive species, including threatened and endangered species. Table 4.1 summarizes the problems focused on in the study.

Table 4.1 – Study Area Problems

General Problem	Specific Problems
Channel Instability	(1) Declining habitat diversity and sustainability
	(2) Declining quantity and quality of in-stream aquatic habitat
	(3) Declining quantity and quality of wetland and riparian habitat
	(4) Declining habitats for sensitive, threatened, and endangered species

To solve problems in the study area, they need to be viewed as opportunities. Table 4.2 presents opportunities to address problems and thereby achieve the study goals and objectives.

Table 4.2 - Study Area Opportunities (Planning Objectives)
(1) Restore habitat diversity and sustainability
(2) Increase the quantity and quality of in-stream aquatic habitat
(3) Increase the quantity and quality of wetland and riparian habitat
(4) Restore habitats for sensitive, threatened, and endangered species

4.3 Significance of Environmental Resources and Degradation

The significance of the project area and it's environmental resources is a function of it's geologic location. The alluvial outwash plain provides riparian and aquatic habitat critical for the life cycle requirements of species within the surrounding Yellowstone ecosystem. The following paragraphs describe the significance of environmental resources within the study area.

The greater upper Snake River begins in Yellowstone National Park and flows in a southerly direction into the Franklin D. Roosevelt National Park before entering Jackson Lake. Jackson

Lake controls about one-third of the flow that enters the project area. From Jackson Lake, the Snake River enters Grand Teton National Park before entering the project area below Moose, Wyoming. Within the project area, from Moose to the South Park National Elk Feedgrounds, the river flows through mostly private riparian properties. Below the Elk Feedgrounds, the river enters a steeper canyon area that is managed by the USFS. The river then enters Palisades Reservoir at the Wyoming-Idaho boundary. The project area constitutes most of the privately owned lands surrounding the Snake River in the region. Throughout most of the ecosystem, the river and its surrounding areas are publicly owned and managed.

The uppermost section of the Snake River within Yellowstone and Rockefeller National Parks is within a pristine natural ecosystem with little to no man-induced degradation. From Jackson Lake downstream the river remains within a pristine ecosystem with the exception of its flow-regime, which is altered by the operation of Jackson Lake. Within Grand Teton National Park, the Snake River follows a natural meandering, semi-braided pattern to Moose, Wyoming. Below the town of Moose, within the study area, the flood plain widens, the slope of the valley increases, and the river forms a braided system. Below the South Park National Elk Feedgrounds boundary, the geology changes, and the river enters a more confined canyon. The terrestrial ecology of the river above and below the project area is a naturally functioning ecosystem managed by the U.S. Department of Interior and the USFS.

4.3.1 Significance and Degradation of Riparian Habitats

This wider braided section of the Snake River had historically provided some of the most valued riparian habitats within its ecosystem. The riparian habitats were characterized by the braided character of the channels forming a diversity of islands and wetlands and supporting various life forms of vegetation. The natural cycle of flooding and channel shifts resulted in habitats ranging from submerged aquatic riverine, to emergent scrub-shrub, willow-alder habitats to sapling and mature deciduous cottonwood stands. The area provided habitat for five endangered species and a wide diversity of fauna from river otters and waterfowl to bald eagles. One the area's most important national values was its wintering habitat. During the severe Jackson Hole winters, when temperatures reach minus 20 °F and minus 30 °F and when snow can accumulate to several feet, big game such as elk, mule deer, and especially moose moved into the valley for cover and food. The proposed project area also provides critical wildlife corridors for the movement of mammals between summer and winter ranges.

Due to the need for erosion and evulsion protection within the project area, the Corps constructed the flood control levee system. When the levees were constructed in the early 1950's through the 1970's, two distinct impacts occurred. The levees provided flood protection which encouraged the construction of homes, which displaced wildlife habitat. The second significant impact was the concentration of flows and the loss of riparian habitats between the levees. The islands of mature cottonwoods and diverse wetland communities have been replaced by single or double river channels with enlarged barren cobble islands. The wildlife cover, food, and corridor values have been significantly reduced.

4.3.2 Significance and Degradation of Aquatic Habitats

The fisheries value of the Snake River remains in a natural state above the study area within Yellowstone and Rockefeller National Parks. The upstream sections above Jackson Lake within Yellowstone and Grand Teton National Parks are pristine, but the overall productive value is low. Since this area is geologically young, the waters that flow over the bedrock and poorly formed soils contain limited nutrient loads. Below Jackson Lake in Grand Teton National Park, the natural integrity of the system remains intact but is influenced by irrigation flows from Jackson Lake. Below Moose, Wyoming, in the study area, the character of the river channel and its aquatic resources have changed dramatically.

The study area has historically been characterized by richer, older flood plains that contributed increased productivity to the aquatic system. The once braided, multi-channel system with its diverse adjacent habitats has been replaced with a single or double channel and cobbled shoreline. The value of the shoreline and the diversity of the braided river channel has changed significantly. As the leveed reach has become increasingly less diverse, overwintering habitat has become a significant limiting factor for some species. Survival through the harsh low-flow winter months is a critical life cycle requirement. Harsh winter temperatures and low flows limit cutthroat trout survival. During the winter months trout can survive only in pools that provide protection from ice and predators. Winter predators such as bald eagles, river otters, and fish-eating waterfowl can easily prey on the trout within their restricted areas of habitation. Recent studies have shown that mature cutthroat trout move from below Jackson Lake to the project reach to survive the winter. Not only do the mature fish move downstream, but there is also some evidence that fish from the canyon area may move upstream to survive the winter.

4.3.3 Institutional, Public and Technical Significance of Area Resources

The significance of natural resources in the study area is clear. Technical studies have identified the importance of diverse and productive riparian and aquatic habitats for the survival of fish and wildlife through the ecosystem's harsh winters. Institutional significance of the study area is demonstrated by its endangered and threatened species. Public significance is demonstrated by the strong local support for the proposed project as evidenced by the sponsor's construction of a demonstration project in the study area. The study's evaluation of significance is further described in the following section.

4.4 Scoping of Study Area

The area covered by the reconnaissance study included the Snake River and tributaries, and the associated 500-year floodplains in the vicinity of Jackson Hole, Wyoming. The reconnaissance study reach was bounded by Moose, Wyoming, near the southern boundary of Grand Teton National Park, and the U.S. Highway 26 Bridge crossing approximately 7 miles south of Jackson, and had a floodplain area of roughly 25,000 acres. The array of Federal levees constructed in the 1950's and 1960's generally reduced the floodplain area to 2,500 acres, or only 10 percent of the original extent. An initial Project Study Plan for the feasibility study again involved the entire 500-year floodplain from Moose to South Park Feed Ground. In order to control study costs and make data collection and analysis feasible, the study team reviewed aerial photography and data generated during the reconnaissance study to select 12 sites that provide the best opportunity for restoration from a fluvial geomorphology and wildlife habitat standpoint.

A new Project Study Plan was then developed for the 12 specific sites. The twelve sites are shown in Plate 3. The cost of the study was reduced from over \$3 million to just under \$2 million, a significant reduction, but still out of the range of the sponsor's fiscal ability. It became apparent that further efforts to reduce cost could not be effective without further reductions in the overall scope of the study. In an effort to reduce the scope, it was decided to determine and describe the overall environmental significance of each site. The overall study area has high national environmental significance as described in the *Jackson Hole, Wyoming, Flood Damage Reduction, Fish and Wildlife Habitat Restoration, Reconnaissance Report* (June 1993). To formulate a reduced scope, each of the 12 sites was evaluated in regard to its individual

significance resulting the identification of 4 sites for detailed evaluation. The screening process is described below.

4.4.1 Significance-Based Preliminary Screening Framework

In 1983, the U.S. Water Resources Council published the *Economic and Environmental Principals and Guidelines for Water and Related Land Resources Implementation Studies* (P&G). The methodology in P&G is the analytical procedure currently used by the Corps in evaluating alternative water resources projects. To be considered in plan formulation and evaluation, P&G requires that environmental resources be "significant." Significant environmental resources are defined as those that are institutionally, publicly, or technically recognized as important. As defined in P&G, the term of significant means "likely to have a material bearing on the decision-making process." In terms of environmental plan formulation and evaluation, the significance of environmental resources based on their nonmonetary values may be established by institutional, public, or technical recognition of the importance of the environmental resources or attributes in the study area.

a. Institutional Recognition. The study areas are institutionally recognized by several national laws and regulations. Part of the original area in the reconnaissance study was within Grand Teton National Park with the remainder immediately downstream and adjacent. The southern most section of the study area is adjacent to South Park National Elk Feedgrounds (a state preserve for wintering elk). Within the project area are six bald eagle nesting territories and habitat for five other nationally recognized endangered species. Over 50 percent of the project is classified as wetlands. The scarcity of structural and biological resources which directly support institutional resources was addressed in this study.

b. Public Recognition. As indicated in the project support section of this document, the study area receives significant interest from local and regional environmental groups. The study area is also used by sportsman and recreationists from across the United States. The area, located between a national park and national forest, has considerable recreational value. The fine-spotted-cutthroat trout is an endemic wild fishery that provides an $11 million fishery to the county. The study has the potential to improve its value .

c. Technical Recognition. Spring creeks are relatively small streams fed by groundwater discharges of clean, clear water of relatively uniform annual temperature. They provide the critical spawning habitat for fine-spotted-cutthroat trout, which in turn provide a forage base for bald eagles. All eagle nesting habitats in the project area are associated with spring creeks.

All 12 sites were ranked individually based on their institutional, public, and technical recognition. Significance rankings are listed in Table 4.3.

Table 4.3 – Site Significance Rankings

SITE RESTORATION - COMPARING 12 ALTERNATIVE STUDY AREAS

CRITERIA RATING INDICES:

BEST	1
AVERAGE	2
WORST	3

RAW SCORES:	NATIONAL SIGNIFICANCE CRITERIA			
	Institutional Recognition	Public Recognition	Technical Recognition	Totals
	(1)	(2)	(3)	
MEASURE:				
ALTERNATIVE 1	1	1	1	3
ALTERNATIVE 2	1	1	1	3
ALTERNATIVE 3	1	1	1	3
ALTERNATIVE 4	1	1	2	4
ALTERNATIVE 5	2	2	3	7
ALTERNATIVE 6	2	2	3	7
ALTERNATIVE 7	2	2	2	6
ALTERNATIVE 8	3	3	3	9
ALTERNATIVE 9	1	1	3	5
ALTERNATIVE 10	1	1	1	3
ALTERNATIVE 11	1	2	2	5
ALTERNATIVE 12	1	2	2	5

4.4.2 Multi-Objective Analysis for Site Selection.

To further refine the scoping effort, a multi-objective approach was developed. Objectives developed with public input during the reconnaissance phase and refined at the Reconnaissance Review Conference were used in a matrix analysis. The study objectives were defined as:

wetland restoration--riverine and palustrine; riparian restoration--island protection and restoration; and endangered species habitat protection and creation.

A multi-objective analysis was conducted using the following objectives:

- Channel Creation. Channel creation to restore fisheries--wetland values dependent on surplus gravel and disposal options (*i.e.*, users of gravel).
- Island Protection. Island protection measures to preserve riparian island values.
- Island Restoration. Island restoration measures to restore lost riparian values.
- Fish Habitat Creation. Fish habitat creation (low energy areas in high energy environments) through stream structure alteration (*i.e.*, spur dikes).
- Headgate Opportunities. Headgate opportunities to provide for future water diversions to restore spring creeks and wetland-riparian habitats.

The ratings for each of these objectives for each project area are listed in Table 4.4.

Table 4.4 – Restoration Features Comparison

SITE RESTORATION – COMPARING 12 ALTERNATIVE STUDY AREAS

CRITERIA RATING INDICES:

BEST 1
AVERAGE 2
WORST 3

RAW SCORES:	MULTI-OBJECTIVE ENVIRONMENTAL CRITERIA					
	Channel Creation	Island Protection	Island Restoration	Fish Habitat Creation	Headgate Opportunities	Totals
	(1)	(2)	(3)	(4)	(5)	
MEASURE:						
ALTERNATIVE 1	1	1	1	1	3	7
ALTERNATIVE 2	1	1	1	1	2	6
ALTERNATIVE 3	1	1	1	1	1	5
ALTERNATIVE 4	1	1	1	1	3	7
ALTERNATIVE 5	2	2	2	2	1	9
ALTERNATIVE 6	3	2	2	2	3	12
ALTERNATIVE 7	3	1	1	1	2	8
ALTERNATIVE 8	3	3	3	3	3	15
ALTERNATIVE 9	1	2	2	2	1	8
ALTERNATIVE 10	2	1	1	1	1	6
ALTERNATIVE 11	3	2	1	1	2	9
ALTERNATIVE 12	3	2	2	2	3	12

The values relating to overall national significance and environmental engineering feasibility were integrated, and the multi-objective analysis was given a 1.5 weight to select the four sites that provide the best overall opportunity for success. The multi-objective approach was given additional weight because the sites providing the most opportunity provided a synergistic effect and the greatest overall opportunity. Six sites provided similar opportunity. Three sites on the downstream reach had very similar ratings and opportunities for restoration. The study team decided to allow the scoping process with local input and specific knowledge of property ownership and cultural concerns to select the best site of the three downstream sites of equal value. The four sites selected are one of either Area 1, 2, or 3 (Area 1 was selected) and Areas 4, 9, and 10.

Table 4.5 – Site Comparisons

SITE RESTORATION - COMPARING 12 ALTERNATIVE STUDY AREAS

CRITERIA RATING INDICES:

BEST	1
AVERAGE	2
WORST	3

RANKED INDEXED SCORES:

APPLY 28.5% IMPORTANCE FACTOR TO 3 PUBLIC AWARENESS CRITERIA

APPLY 71.5% IMPORTANCE FACTOR TO 5 MULTI-OBJECTIVE ENVIRONMENTAL CRITERIA

		Index Application Rate Per Criteria	Number of Criteria	Total Index Points	Index Application Rate per Criteria	Number of Criteria	Total Index Points	Grand Total Index Points		
RATING:										
BEST	1	0.095	3	0.285	0.143	5	0.715	1		
AVERAGE	2	0.19	3	0.57	0.286	5	1.43	2		
WORST	3	0.285	3	0.855	0.429	5	2.145	3		

	NATIONAL SIGNIFICANCE CRITERIA			MULTI-OBJECTIVE ENVIRONMENTAL CRITERIA					
	Institutional Recognition	Public Recognition	Technical Recognition	Channel Creation	Island Protection	Island Restoration	Fish Habitat Creation	Headgate Oppor-tunities	Totals
MEASURE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Alternative 3	0.095	0.095	0.095	0.143	0.143	0.143	0.143	0.143	1
Alternative 2	0.095	0.095	0.095	0.143	0.143	0.143	0.143	0.286	1.143
Alternative 10	0.095	0.095	0.095	0.286	0.143	0.143	0.143	0.143	1.143
Alternative 1	0.095	0.095	0.095	0.143	0.143	0.143	0.143	0.429	1.286
Alternative 4	0.095	0.095	0.19	0.143	0.143	0.143	0.143	0.429	1.381
Alternative 9	0.095	0.095	0.285	0.143	0.286	0.286	0.286	0.143	1.619
Alternative 7	0.190	0.190	0.190	0.429	0.143	0.143	0.143	0.286	1.714
Alternative 11	0.095	0.190	0.190	0.429	0.286	0.143	0.143	0.286	1.762
Alternative 5	0.190	0.190	0.285	0.286	0.286	0.286	0.286	0.143	1.952
Alternative 12	0.095	0.190	0.190	0.429	0.286	0.286	0.286	0.429	2.191
Alternative 6	0.190	0.190	0.285	0.429	0.286	0.286	0.286	0.429	2.381
Alternative 8	0.285	0.285	0.285	0.429	0.429	0.429	0.429	0.429	3

4.4.3 Preliminary Screening Results

Thus, the *Feasibility Study* focuses on four proposed restoration alternative sites referred to as Areas 1, 4, 9, and 10. The four sites are shown on Plate 4. The sites are all located within the Snake River in a reach extending from a point 3 miles above the Highway 26 Bridge on the downstream end, to the Gros Ventre River confluence on the upstream end. In the vicinity of the

project reach, the right (west) bank Federal levee is continuous from RM 947.6 (near Area 4) to beyond the Gros Ventre River confluence. The (east) bank Federal levee extends from RM 947.6 (near Area 4) to a point roughly 1.7 miles upstream of the Jackson-Wilson Bridge on Highway 22. The remaining 2.5 miles of bank (4.4 river miles) are currently unleveed.

4.5 Formulation of Alternatives

At each of the four study areas, different restoration features were combined into alternative restoration plans for each site. This section describes the restoration measures that were considered and provides a summary of the different configurations of measures at each of the study areas.

4.5.1 Restoration Measures

Restoration measures consist primarily of: construction of eco-fences; excess gravel removal; placement of logs and root wads designed to protect and reestablish wetland and riparian habitats and; creation of side channel backwater areas and off-channel pools. (See Plates 29 through 33.) The eco-fences will be placed at the front and sides of existing wooded islands to protect an existing resource or in areas where riparian vegetation has been lost in an attempt to regain the lost soil and vegetation. Generally, attempts to regain vegetation area had been limited to that which existed prior to 1973 in order to avoid reducing the level of flood protection that existed at that time. The purpose of the fence structures is to block, slow down, or deflect the force of the current during high-flow periods in order to protect existing vegetation and allow new vegetation to become established. Fences have been used effectively in low velocity regimes in a number of other instances. Their long-term effectiveness in the high-velocity regime that exists in the area covered by this study remains to be demonstrated.

Gravel and cobbles will probably accumulate to some extent with any reduction in the flow velocity, but flows must be reduced well below 2 fps if a layer of soil is to be reestablished. Willows, and other vegetation which grow in the gravel bed will assist in reducing velocities and encouraging the deposition of silt if they can be protected from direct attack long enough to become established. As vegetation becomes established it further slows flow velocities and encourages accelerated sedimentation.

If a fence fails to perform satisfactorily, it is possible to add more cross cables or wire mesh to increase the trapping efficiency of the structure. A few seasons of operation may be required to measure the effectiveness of the fences and to adjust the existing fence designs for optimum performance. If the fences operate successfully, debris will be swept by the eddy current into the space between each fence, and a raft of logs, limbs, and other flotsam will collect upstream of the fences and form the matrix through which willows and other vegetation will become established. Sand and gravel will collect in the triangular, protected zone downstream of each fence. As vegetation becomes established it will further resist the flow and encourage the accumulation of a new layer of silt, which will support progressively larger varieties of vegetation.

In most cases, the fences will have very little effect on overall river conveyance since they are generally located where conveyance is reduced (*i.e.*, near the banks of existing islands), or where the river has ample room to cut a channel around the protected area. At other locations the fences protect and maintain existing stands of timber, which presently block most of the flow through the affected area. Proposed fences, which encroach on open areas, will nearly always be located where heavy stands of mature vegetation and soil once existed (but were removed by flood flows) and at the site of previously blocked most flood flows.

Gravel removal is designed to accomplish several objectives. In some areas gravel will need to be removed initially in order to increase the capacity of the stream and offset the loss of conveyance resulting from the eco-fences. The stream would naturally enlarge the channel and regain its conveyance with time, but a flood coming in the season following the completion of the fence might raise the water a small, but unacceptable amount above the regulatory flood level. Oversize gravel (the +4 inch material, which generally constitutes from 5 to 20 percent of the mixed gravels in the bed) will be retained and returned to the channel bed and the upstream ends of adjacent islands. This large material is more resistant to movement and actually forms a protective armor layer when flow velocities are below the critical shear stress for the available sizes.

A second function of gravel removal is to reduce the supply of gravel to an area that is overloaded. This, if combined with measures that increase gravel bar stabilization, will result in channel entrenchment and a reduction in the rate and frequency of lateral movement. A third function is to take the pressure off of an eroding bank by opening up existing secondary channels and shifting some of the flow back toward the center of the meander belt. Eco-fences and anchored debris are designed to encourage vegetation growth and help to stabilize the channel

pattern. The level of success in maintaining an alignment will probably vary widely with the location and degree of bank stabilization accompanying the gravel removal.

The above objectives could be achieved with reasonable confidence in a meandering channel with a low sediment load. However, the Snake River carries a heavy bedload and is very unstable and braided. It is very difficult to determine how much sediment is being transported, where sediment will be deposited next, or where the channel will be after the next flood. By its very nature, the river is unpredictable and may not respond as desired in some areas.

Changes in sediment transport and river hydraulics, resulting from the implementation of various restoration measures, will have environmental impacts, which will need to be considered. In the remainder of the report the term "improved channel" is sometimes used interchangeably with the term "restored channel" to refer to the modified condition after restoration measures have been implemented in an area.

The grain sizes of materials on the surface in the study areas vary considerably from silt to cobbles 5 to 10 inches in mean diameter. The size depends to a great degree on the velocity of flow at the particular location. However, a foot or more below the surface the material is more uniformly distributed with very little silt and generally less than 15 percent larger than 4 inches. When the river is returned to flow over an excavated area there will be an initial increase in turbidity as the flow picks up the fine material from the surface. This should be of very short duration, perhaps a few hours. Later on, as the flow increases during winter floods or the spring runoff period, the bed will be reworked, and one of several processes will dominate. Fine material in the bed will be entrained and put into suspension. Then, depending on the sediment supply from upstream, more sediment will be deposited than is entrained; an equilibrium will be established between entrainment and deposition; or, if there is a deficient supply, erosion of the bed will occur until enough the large material remains to form a new continuous layer over the bed which will protect the underlaying material from further erosion.

Cobbles which form the new armor layer would come from material transported into the site from upstream, oversize material physically returned to the bed during gravel-removal operations, and material existing in the bed. In the extreme case, with a deficiency of supply from upstream, and no return of cobbles to the bed, the channel bed could degrade to a depth of 2 to 10 feet depending on the amount of large sized material in the bed. Restoring the +4 inch material will significantly reduce the depth of degradation from an average runoff event, since this material will be redistributed over the surface by the current to form a new armor layer.

In some areas root wads or logs will be anchored. The root wads are designed to accomplish some of the same objectives as the eco-fences. They will have less of a visual impact and should spread the effect over a larger area. In areas of low velocity sand and silt will collect downstream of the debris and encourage the establishment of vegetation. In higher velocity areas, a sufficient number of root wads will tend to slow the velocity and deflect most of the current around the area to be protected. In some areas, when exposed to the main current the root wads will actually increase erosion by flailing around on the restraints and stirring up the gravel. In these areas, holes, several feet in depth, will be eroded in the channel where each root wad is anchored.

4.5.2 Design Criteria for Restoration Measures

For purposes of comparing the costs and benefits of different levels of protection, it was necessary to select criteria for design and assign a probability of success to various elements of the design. Since there was virtually no historic data of a type that could be used for a rigorous probability analysis for this type of project, probabilities were primarily based on experience and judgment.

The maximum design life of 50 years seemed to be a reasonable value, since woody vegetation will reach a mature level during that time. It also corresponded roughly to the period of aerial photographic data documenting changes in the channel and surrounding vegetation. During the past 50 years, virtually all of the vegetated islands within the meander belt were destroyed at one time or another by the changing channel patterns. In order to provide a comparison, shorter design periods that actually represent intermediate levels of reliability in the selection of structural elements and restoration measures were selected.

From the frequency curves shown in Appendix B, Hydrology, it can be seen the peak annual discharges for average return intervals of 15, 25, and 50 years are 22,500, 24,000, and 26,500 cfs. Obviously there is not enough difference in these flows to serve as a criteria for design of structures whose probability of failure is related more to attack by impinging flows, impact by floating debris, and changes in channel alignment, than by a specific flood frequency. For this reason it was decided that a design based on attack by floating debris under three different impinging flow velocities along with the traditional static hydraulic loading, would be a

more reasonable approach. Impinging flow, for purposes of this analysis was defined as flow that had a much greater attack velocity due to a local steepening of the upstream channel.

The design impingement velocities were based on expected levels of attack. Velocities of 4 fps or greater could be expected when the structures were exposed to high flows even without impingement conditions. For this reason structures should not be designed for anything less than 4 fps. Impinging velocities of 8 fps were frequently seen in the data, and 12 fps occasionally appeared in the data. These velocities were used as a basis for the development of four separate fence designs.

Structures designed for 4 fps would suffer substantial damage if exposed to direct attack by an typical impinging flow. The probability of being exposed to this type of flow may range from 5 to 10 percent each year based on a rough estimate of the length of levee exposed to impinging flows. If 7 percent of the structures were substantially damaged each year, this would roughly correspond to a 15-year life for structures designed for 4 fps. Structures designed for 8 fps would be more likely to survive some impinging attack, perhaps providing a 25-year average life. However, with the present design, the structures would not provide enough continuity to restrict the channel to a fixed alignment.

The braided channels will eventually bypass even the strongest structures, attack the vegetated islands from an unprotected angle and eventually render many of the structures useless. It does not seem reasonable, based on the past erosional history of the river, to assign a project life greater than 50 years. Vegetative growth was based on the assumption that over the entire project the average, effective life of the fences would correspond to the selected intervals. On an average, substantial reconstruction of the entire project would be required at the indicated intervals.

In some areas the restoration measures may be very successful, in others there is likely to be extensive failures. By analyzing past erosion trends and channel patterns, an attempt has been made to maximize the probability that most of the measures will be located in areas where they will meet with an acceptable level of success.

4.6 Description of Restoration Alternatives at the Four Project Areas

This section provides a description of the management measures that make up each of 4 alternatives at each of the 4 study sites for a total of 16 alternatives. Area 1 is described first, followed by Areas 4, 9, and 10.

4.6.1 Proposed Restoration Measures for Area 1

This section provides a site description for Area 1 and identifies specific proposed restoration measures.

4.6.1.1 Area 1 Description

Area 1 encompasses a long sweeping bend in the Snake River and its associated overflow channels and wooded riparian zone (see Plates 4 and 16). It is located about 3 miles upstream of the Highway 26 Bridge, starting at the confluence of Spring Creek and extending upstream about 2 miles. The Snake River enters the area flowing generally south, then swings nearly 90 degrees to the east as it comes up against the Snake River Range which blocks its southward path along the lower one-third of this area. The river and its adjacent wooded riparian zone spreads out to a width of about one mile around the bend, but narrows to 2,000 feet or less where the braided channels converge at the lower end. At present the river generally flows around the outer edge of the riparian zone. During high-flow periods, the river overflows into a network of smaller channels that cut across the bend and empty back into the Snake River along the lower half of the bend. During low-flow periods the upper ends of these channels may be dry, but progressing downstream, water seeping in from the shallow aquifer keeps the larger branches flowing during the entire summer.

The channel is highly braided, with 2- to 5-degree braiding over most of its length. The adjacent floodplain is wide and flat. During high-flow periods the channel boundaries are poorly defined and constantly changing. Gravel may completely fill the channel at some locations causing the flow to fan out over a wide area.

A review of historic aerial photographs indicates that the active channel has frequently changed course and pattern. A USGS quad sheet, based on surveys taken 1927-31, indicated that the

channel at that time was more centrally located within the meander belt and divided into three main branches. Both of the east branches emptied into Spring Creek, which joins the Snake River at the downstream end of the bend. By 1945 it appeared that the central branch of the channel was being abandoned, but a large channel still cut across to Spring Creek. Over the years the channel moved westward, progressively eroding a 1,000-foot wide wooded riparian zone and cutting into developed pasture lands to the west. In the process the river almost completely abandoned the branch into Spring Creek. Sheet flow still covers the interior gravel bars during spring floods, but willows are springing up, and sand and silt is building up on large expanses which were formerly bare cobbles.

The date for the most recent westward channel movement is not known. There was some westward erosion evident in 1956. A couple of loops were cut into the zone between 1960 and 1962. Large areas of vegetation were washed away between 1967 and 1971, between 1974 and 1981, in 1986, and between 1992 and 1996.

Near the downstream end of Area 1 a large portion of the Snake River formerly flowed into and along the present course of Spring Creek and then flowed back into the main channel from the left. The momentum of the lateral flow and sediment replenishment from this branch of the Snake River probably tended to keep the channel pushed up against the hills to the south. A groin, located just above the confluence on the left side, can be seen in 1953 aerial photos, but appears to be partially or completely destroyed in 1956 photos. Since 1962 the river has progressively cut away slices of the left bank. By 1996 the river had cut nearly 800 feet into riparian land near the mouth of Spring Creek.

Several factors suggest that the river is either moving large volumes of gravel with no net loss; or the area is aggrading:

- The riverbanks are poorly defined or nonexistent.
- The river is invading new areas beyond the meander belt.
- The meander belt is 3 to 4 times as wide as the active channel.
- During peak flow conditions, flow is often shallow and spread out over mid-channel islands which appear to include most of the channel cross section.
- There is an absence of recent terrace formation or other evidence of channel entrenchment.

The low-flow channel exhibited a wide variation of patterns over the years. During some years, such as in 1996, a definite, repeated pattern of fairly uniform meander loops could be seen within the overall braided pattern. In 1945 there was little, if any, regular meandering pattern identifiable within the overall braiding. The 1996 pattern appeared to be more typical of identifiable patterns during the 1945-97 period.

4.6.1.2 Area 1 Restoration Measures

a. Channel Alignment. The natural channel pattern will be retained and allowed to develop to the extent possible. However, several existing channels will be enlarged, as indicated on Plate 16, to shift some of the flow back toward the center of the meander belt, take some of the erosive pressure off of the right bank, and allow reestablishment of a riparian zone in this area.

b. Removal of Excess Gravel. A gravel-removal zone, designed to match a typical second-degree braiding pattern, was selected at the upstream end of Area 1. Removal of excess gravel at this location will reduce the supply downstream, encouraging moderate entrenchment of the downstream channels and reducing the frequency and extent of lateral movement. Cobbles over 4 inches in mean diameter will be retained to form an armor layer on the bed and banks of the channel.

The Area 1 gravel removal site was chosen for the following reasons:

- The location allows easy access along the west side from the Taylor Creek Levees or the nearby county road.
- The location will reduce the supply of gravel entering the site while minimizing the area that will be disturbed while excavation is in progress.

During hydraulic modeling of the channel modifications described above, it was found that the eco-fences resulted in a calculated rise in the water level upstream. To offset the effect of the fences, additional excavation is proposed along several existing, secondary channel alignments. This excavation should take some pressure off of the right bank by shifting a majority of the flow back toward the center of the meander belt. The channel modifications will shorten the effective length of the channel and increase the channel conveyance. The sediment supply will be reduced by the upstream sediment trap. If successful, these modifications should maintain adequate

conveyance through this reach in the future with little or no maintenance. After completion of the project, the area should be monitored by periodic resurveys of sediment ranges to assure that the amount of sediment removed from the sediment trap does not result in excessive channel entrenchment downstream.

c. Pool and Channel Restoration. Two existing channels were identified and selected for restoration measures. Four pool sites were selected along these channels. The selected sites provide varying degrees of exposure to erosion and sediment inflow. The two pools farthest from the main channel will collect finer sediment and should survive the longest. Connecting channels and associated pools will create flow and depth diversity. Root wads and other in-water debris will provide shade and shelter for fish and other aquatic life.

d. Eco-Fences. Eco-fences and root wad fields along the west bank of the channel are designed to collect sediment, and encourage woody vegetation growth. The objective is to stop westward channel movement and recover most of the riparian habitat lost since 1973. The proposed locations for eco-fences cover areas formerly occupied by mature riparian vegetation, which has been destroyed since 1973. Eco-fences on the left side of the channel are designed to protect large stands of mature cottonwoods should the river shift back eastward across the meander belt. As experience is gained, it may be necessary to make some adjustments or modifications to the fences in order to improve their debris-trapping efficiency or to control erosive velocities between the fences. The modifications might consist of the addition of fence spurs connected to the existing fences or the placement of additional fences or fence panels between the existing fences.

4.6.2 Proposed Restoration Measures for Area 4

4.6.2.1 Area 4 Description

Area 4 covers a braided reach of the river starting at the downstream end of the Federal levee project and extending downstream a distance of 1.6 miles. Fish Creek, Mosquito Creek, and Cottonwood Creek enter the Snake River from the right (see Plates 4 and 17). The Upper Imenson Levee forms a boundary to the left. Prior to construction of the Federal levee project the river often followed an alternate course well to the right of the existing levees, with a significant flow following the present course of Fish Creek. During high-flow periods some of

the flow escaped into spring creeks which branched off of the main channel in the riparian zone to the left. Levees and levee extensions now cut off most of the overflow into these channels.

Historic aerial photographs indicate that the river was rather unstable in this area. Flows followed alternate paths through the area, sometimes spreading out over a fairly wide expanse, and at other times cutting a single narrow channel through the reach. A characteristic, low-flow meander pattern did not appear to be present in this location. The active meander belt has experienced considerable lateral expansion between 1954 and the present. Large areas were eroded in 1973, and again in the 1986-97 period. Between 1945 and 1954 the active, vegetation-free zone of the channel occupied an average width of about 1,000 feet. In 1977 floodwaters spread out to a width of 2,400 feet with very little vegetation left in between. The location and method used in previous cross section surveys do not provide a sufficiently accurate basis for analyzing gravel erosion or deposition in this area. However, several factors strongly suggest that gravel is building up again in this area:

- The levees immediately upstream of the study area have severely restricted the opportunity for flood flows to spread out and flow into alternate channels. Gravel transport and deposition is now restricted in the area between the levees.
- Repeated resurveys of monumented sediment ranges in the upstream Federal levee reach indicate a net loss of gravel between the levees.
- Termination of the right-bank levees theoretically provides an opportunity for transported gravels to drop out as the flow spreads out over the unrestricted floodplain.
- The evidence of progressive widening of the meander belt is consistent with the expected response of the meander belt to excessive gravel deposition in this area.

4.6.2.2. Area 4 Restoration Measures

a. <u>Channel Alignment</u>. The channel at this site has been extremely unstable over the last 50 years, with no identifiable, characteristic, low-flow channel pattern. The low-flow channel pattern utilizes an average meander length observed at other sites within the overall study reach, and represents a pattern that the channel may naturally assume after implementation of restoration measures. If the channel has shifted to the far right or left side of the meander belt prior to project implementation, some excavation may be required along the indicated channel alignment in order to shift the low-flow channel back to the center of the meander belt. This

should be a one-time operation. The channel pattern, gravel excavation sites, and other restoration measures for Area 4 are indicated on Plate 17.

b. Removal of Excess Gravel. The supply of gravel entering this site from upstream will be reduced in order to increase channel stability. Two areas were designated for gravel removal. The size of these sites has no bearing on the amount of gravel to be removed. The maximum area of disturbance during any year will be less than one-half of the delineated areas.

The Area 4 gravel removal sites were chosen for the following reasons:

- The locations provide easy access for equipment using levee access roads along both sides of the river.
- The shape and size of these sites match active gravel exchange areas at these locations, as observed in the 1996 aerial photos. The shape of the upper site was modified to allow room for partial recovery of vegetation and soil lost on a nearby wooded island since 1973.
- Location of the gravel sites along the left bank provides a high degree of assurance that gravel will be intercepted before it enters the area of greatest instability. Large cobbles will be retained during gravel removal and will be used to armor the upstream and downstream ends of the pools.

c. Pool and Channel Restoration. In addition to the gravel sites, three smaller sites were selected off of the main channel where they would be fed by spring creeks or secondary channels, and where they would be protected to some degree from direct erosive attack during flood flows. The small channels feeding and draining the two larger pools will provide opportunities for fish habitat improvement.

d. Eco-Fences. Eco-fences will be used to protect several existing islands supporting mature woody vegetation. The fences will be designed to collect debris and to slow and deflect the flow during average spring runoff periods, but they will be over-topped during extreme floods.

e. Spur Dikes. Groups of spur dikes will be located at two points along the levees. These dikes will provide velocity diversity and resting areas for fish. Properly spaced, they could provide a secondary benefit by providing increased erosion protection for a short reach of the levee.

4.6.3 Proposed Restoration Measures for Area 9

4.6.3.1 Area 9 Description

Area 9 covers a 1-mile reach of the Snake River in the vicinity of the Jackson-Wilson Bridge (see Plates 4 and 18). The downstream limit is just below the Jackson-Wilson Bridge. The upstream limit is about 700 feet upstream of the Prosperity Ditch intake. The earliest available map for this area is a 1946 USGS quad sheet, which was a reprint of a 1901 map, based on 1899 topographical surveys. This map indicates that the channel was braided at that time. Within the study reach, the lower two-thirds of the channel was divided into two main channels that extended downstream through the Jackson-Wilson Bridge. Later maps and aerial photos showed a similar pattern. Rock-filled timber-cribs were used to construct bridge approach walls, four large spur dikes on the left bank, and an isolated section of levee at the Prosperity Ditch inlet. These structures were included in 1938 maps of the area. Several of the spur dikes can still be seen along the left bank upstream of the bridge.

The bridge forms a rather severe constriction in the active meander belt. During the early and middle 1950's the active channel widened considerably just upstream of the bridge. This may have been a response to unusually high flows and associated gravel deposition upstream of the bridge. Levee construction immediately upstream of Area 9 probably resulted in additional transport into this reach. The area of exposed gravel increased by 28 percent between 1944 and 1953, leaving only 15 percent of the meander belt in vegetated islands. Construction of the levees through this area in the late 1950's and early 1960's narrowed the active meander belt, funneled flows through the bridge, and probably increased the efficiency of gravel transport through this area. In 1996 there was actually more vegetative cover than in the 1950's and early 1970's. Aerial photographs indicate rather extensive gravel removal below the bridge along the left bank and at the upstream end of the study reach in the 1960's and early 1970's. Part of the removal work was for levee construction.

4.6.3.2 Area 9 Restoration Measures

a. Channel Alignment. The alignment for channels in this area follows a typical alternating pattern that has existed since about 1960. By encouraging the river to follow one or both of the selected channels some vegetation growth should be possible in areas which were frequently

destroyed by the shifting channel. Some excavation will be needed, at least initially, to stabilize the channel until vegetation can become established.

b. Gravel Removal. Some gravel removal will be required to keep the selected channels open, and to provide additional flow area to offset flow resistance caused by new vegetation growth. If restoration measures are effective, only limited gravel reshaping or removal may be needed in the future. Cobble sized material will be returned to the bed and to the upstream ends of islands to retard erosion.

c. Pool and Channel Restoration. Several pool sites were selected in the protected area near the left bank levee. Sites were selected where direct exposure to the main current would be minimized. Small secondary channels connecting these pools should provide opportunities for fish habitat improvement.

d. Eco-Fences. Eco-fences are designed to reduce velocities and collect sediment, allowing the soil to rebuild and vegetation to extend out from the remnants of a wooded island. Cobble armor and anchored root wads will be used to break the force of the current and allow vegetation to become reestablished on islands between the selected channels. Abandoned bridge piers will serve as anchors for some of the fencing.

e. Spur Dikes. Groups of spur dikes will be located at three points along the levees where flow impingement or long reaches of sustained, high-velocity flow is expected. These dikes will provide velocity diversity and resting areas for fish. They will also strengthen and increase the effectiveness of the adjacent levees.

f. Bed Stabilization. A bed of rock is shown connecting the left bank levee with the debris fences. This material is designed to allow passage of flood flows while preventing the establishment of a permanent channel through the protected area along the left bank levee.

4.6.4 Proposed Restoration Measures for Area 10

4.6.4.1 Area 10 Description

Area 10 covers a 2-mile reach of the Snake River at the Gros Ventre River confluence (see Plates 4 and 19). The Snake River runs south, directly into Gros Ventre Butte, then turns west in the lower half of the study reach. The earliest available map for this area is a 1946 USGS quad sheet, which was listed as a reprint of a 1901 map with some roads and other development added. The map topography was surveyed in 1899. This map depicted a braided channel pattern with up to three main branches. The Gros Ventre appeared to enter the Snake River over 1,000 feet upstream of its present confluence. A 1938 map indicated a similar degree of braiding with a somewhat different channel pattern. A 1944 aerial photograph shows the Gros Ventre channel split as it approaches the confluence with part of the flow following the old channel route and the other part entering at the present confluence location.

Aerial photos from the early 1950's indicate that the river was highly unstable with large areas of exposed gravel upstream of the Gros Ventre River and near the downstream end of the study area. However, downstream of the confluence for about one-half mile the channel was surprising stable with vegetation growing relatively close to the active channel banks. By 1960, levees had been constructed along the left side of the active meander belt. The levees followed a secondary channel, enclosing a 60 acre wooded island at the confluence. Since construction of the levees, there has been a moderate expansion of the active meander belt into the wooded riparian zone to the east. The Snake River progressively eroded the confluence island from both sides. By 1996 more than half of the island had been washed away. Additional erosion occurred in 1997. With a new channel cutting through the center of the island, the remaining trees will probably wash away within a few years.

4.6.4.2 Area 10 Restoration Measures

a. <u>Channel Alignment.</u> Although the channel is highly braided, the main channel has usually followed one or more of several identifiable courses through Area 10. Gravel excavation, debris fences, and a short pilot channel are designed to shift the main channel activity back into existing courses toward the center of the meander belt, taking pressure off of eroding wooded islands to the west and riparian growth along the east bank.

b. Removal of Excess Gravel. Two sites were chosen for gravel removal. The upper site captures gravel before it enters the restoration site; it directs flow down through the center of the braided area in two distinct channels. It is designed to encourage moderate channel entrenchment and increased stability of downstream channels. It should reduce pressure on eastward lands and to allow vegetation to become reestablished on interior islands. The lower site reduces gravel inflow from the Gros Ventre River and should take some pressure off of the eco-fences and remains of the wooded island to the west by drawing the main current toward the center of the excavated area.

c. Eco-Fences. Eco-fences are proposed for use to protect Bear Island and reduce flow into the eastward channel. Other fences near the center of the drawing (Plate 19) will be used to restrict flow into the channel along the west levee alignment and encourage eastward accretion of the adjacent wooded islands. The pilot channel (running through Range 28) will be required to take pressure off of the downstream wooded island area and shift flow back to the center of the meander belt.

d. Pool and Channel Restoration. Restriction of flow along the west levee should encourage revegetation of this corridor and provide opportunities for aquatic habitat enhancement in the small secondary channel that remains. Two pools will be developed in this sheltered area with root wads, and other woody debris added to provide shade and shelter.

e. Spur Dikes. Groups of spur dikes will be located at three points along the levees where sustained high velocities are expected. These dikes will provide velocity diversity and resting areas for fish. They will also strengthen and increase the effectiveness of the adjacent levees.

4.6.5 Summary of Restoration Features by Project Area

The main categories of restoration measures are summarized below in Table 4.6 with indication of which measures are proposed for each project area.

Table 4.6 – Configurations of Management Measures by Study Area							
	Gravel Removal			Fences	Barbs	Root Wads	Grade Control
	Channel Capacity	Side Pools	Sediment Traps				
Area 1		X	X	X		X	
Area 4	X	X	X	X	X	X	
Area 9	X	X		X	X	X	X
Area 10	X	X	X	X	X	X	

For each project area, four different designs of fences were evaluated. These designs included three piling eco-fences of different design specifications and one rock fence. The differences in these fence designs are described below.

a. Piling Eco-fences. Several load conditions were used in the design of the piling eco-fence. The load conditions consisted of the following:

- Impact from a floating log on a single pile.
- Impact from a floating log on a cable.
- Static hydraulic head from river flows behind the fence.

The flow velocities used to determine the force for each load condition were 5, 8, and 12 fps. These velocities are representative of the 15-, 25-, and 50-year flood flow velocities. Based on the analyses, piling type, minimum pile penetration depth, and wire rope size were determined. This information is presented in Table 4.7.

Table 4.7 - Piling Sizes		
Water Velocity (feet per second)	Piling	Minimum Penetration (feet)
5	Pipe (6" X 0.432")	12
8	H – Pile (8" X 36")	14
12	H – Pile (10" X 42")	16

Other options were considered, such as attaching a synthetic mesh or round timbers to the piling. It was determined that these options do not have the strength to withstand the river forces for the given flow conditions and were eliminated. Timber piling was also considered for piling and was found to be able to withstand the load conditions with velocities up to 5 fps. However, due to the high bedload movement in the river, timber piling was eliminated from further consideration because the timber would rapidly breakdown.

b. Rock Eco-fences. A rock eco-fence design is considered in order to investigate an alternative to a piling eco-fence that would be suitable for withstanding the high river forces. The rock eco-fences will consist of riprap with side slopes of 2 horizontal to 1 vertical and an embedment depth of at least 4 feet below the adjacent ground line. Riprap will be placed to a top elevation of 1 foot below the 100-year flood. Riprap will be sized to meet gradation 4 (Table 4.6).

4.7 Array of Alternatives for Detailed Evaluation

The four different designs of fences, applied with the other features (gravel removal, dikes, root wads, and grade control) at each of the 4 sites resulted in 16 alternatives for detailed evaluation of costs and environmental benefits in the study.

The 16 alternatives are listed in Table 4.8. The column labeled "Description" indicates the design of eco-fence for each alternative.

Table 4.8 – 16 Alternatives for Detailed Evaluation	
Name of Alternative for Analyses	**Description**
Alternative A1	Area 1, 15-year fence design
Alternative A2	Area 1, 25-year piling eco-fence design
Alternative A3	Area 1, 50-year fence design (piling)
Alternative A4	Area 1, 50-year fence design (rock)
Alternative B1	Area 4, 15-year fence design
Alternative B2	Area 4, 25-year fence design
Alternative B3	Area 4, 50-year fence design (piling)
Alternative B4	Area 4, 50-year fence design (rock)
Alternative C1	Area 9, 15-year fence design
Alternative C2	Area 9, 25-year fence design
Alternative C3	Area 9, 50-year fence design (piling)
Alternative C4	Area 9, 50-year fence design (rock)-
Alternative D1	Area 10, 15-year fence design
Alternative D2	Area 10, 25-year fence design
Alternative D3	Area 10, 50-year fence design (piling)
Alternative D4	Area 10, 50-year fence design (rock)

4.8 Cost of Alternatives

This section provides cost estimates for each of the 16 alternatives. Draft MCACES cost estimates were developed for each alternative and are summarized in Section 4.8.1; broken down by: (1) construction costs; (2) real estate; (3) supervisory and administrative costs; (4) preconstruction, engineering, and design (PED) costs; and (5) O&M costs. Construction costs include components for mobilization and demobilization, materials and labor, field and home office overhead, profit, bond, and contingency. One season is assumed for construction at each site. Annual O&M costs were developed for gravel removal, site armoring, eco-fences, anchored root wads, and bank barbs. Annual O&M costs were applied for each year in the 50-year period of analysis is converted to their present value. The following tables summarize the cost estimates for each of the 16 alternatives.

4.8.1 Study Area 1 Cost Estimates

Table 4.9 – Cost Estimate for Area 1		
Cost Estimate for Alternative A1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$4,734,300	
Real Estate	286,140	
Supervisory & Administrative (6%)	284,058	
PED (9%)	426,087	
TOTAL FIRST COSTS	5,730,585	$408,687
O&M	5,703,489	406,754
TOTAL COST	$11,434,074	$815,441
Cost Estimate for Alternative A2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$4,726,600	
Real Estate	286,140	
Supervisory & Administrative (6%)	283,596	
PED (9%)	425,394	
TOTAL FIRST COSTS	5,721,730	$408,055
O&M	5,687,626	405,623
TOTAL COST	$11,409,356	$813,678
Cost Estimate for Alternative A3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$4,795,900	
Real Estate	286,140	
Supervisory & Administrative (6%)	287,754	
PED (9%)	431,631	
TOTAL FIRST COSTS	5,801,425	$413,739
O&M	5,676,584	404,836
TOTAL COST	$11,478,009	$818,574
Cost Estimate for Alternative A4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$5,849,300	
Real Estate	286,140	
Supervisory & Administrative (6%)	350,958	
PED (9%)	526,437	
TOTAL FIRST COSTS	$7,012,835	$500,133
O&M	5,714,845	407,564
TOTAL COST	$12,727,680	$907,697

NOTE: Real Estate Costs in this table are based on early estimates; however, subsequent changes do not affect the selection of preferred alternatives.

4.8.2 Study Area 4 Cost Estimates

Table 4.10 – Cost Estimate for Area 4

Cost Estimate for Alternative B1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$10,912,800	
Real Estate	99,720	
Supervisory & Administrative (6%)	654,768	
PED (9%)	982,152	
TOTAL FIRST COSTS	$12,649,440	$902,117
O&M	15,580,390	1,111,143
TOTAL COST	$28,229,830	$2,013,260
Cost Estimate for Alternative B2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$10,906,200	
Real Estate	99,720	
Supervisory & Administrative (6%)	654,372	
PED (9%)	981,558	
TOTAL FIRST COSTS	$12,641,850	$901,576
O&M	15,566,796	1,110,173
TOTAL COST	$28,208,646	$2,011,749
Cost Estimate for Alternative B3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$11,086,300	
Real Estate	99,720	
Supervisory & Administrative (6%)	665,178	
PED (9%)	997,767	
TOTAL FIRST COSTS	$12,848,965	$916,347
O&M	15,557,362	1,109,501
TOTAL COST	$28,406,327	$2,025,847
Cost Estimate for Alternative B4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$11,907,400	
Real Estate	99,720	
Supervisory & Administrative (6%)	714,444	
PED (9%)	1,071,666	
TOTAL FIRST COSTS	$13,793,230	$983,688
O&M	15,587,180	1,111,627
TOTAL COST	$29,380,410	$2,095,316

4.8.3 Study Area 9 Cost Estimates

Table 4.11 – Cost Estimate for Area 9

Cost Estimate for Alternative C1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$2,866,000	
Real Estate	67,680	
Supervisory & Administrative (6%)	171,960	
PED (9%)	257,940	
TOTAL FIRST COSTS	$3,363,580	$239,880
O&M	2,869,853	204,669
TOTAL COST	$6,233,433	$444,548
Cost Estimate for Alternative C2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$2,687,600	
Real Estate	67,680	
Supervisory & Administrative (6%)	172,056	
PED (9%)	258,084	
TOTAL FIRST COSTS	$3,185,420	$227,174
O&M	2,871,761	204,805
TOTAL COST	$6,057,181	$431,979
Cost Estimate for Alternative C3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$3,052,500	
Real Estate	67,800	
Supervisory & Administrative (6%)	183,150	
PED (9%)	274,725	
TOTAL FIRST COSTS	$3,578,055	$255,175
O&M	2,855,718	203,661
TOTAL COST	$6,443,773	$458,836
Cost Estimate for Alternative C4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$3,146,500	
Real Estate	67,680	
Supervisory & Administrative (6%)	188,790	
PED (9%)	283,185	
TOTAL FIRST COSTS	$3,686,155	$262,885
O&M	2,859,113	203,903
TOTAL COST	$6,545,268	$466,787

4.8.4 Study Area 10 Cost Estimates

Table 4.12 – Cost Estimate for Area 10

Cost Estimate for Alternative D1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$5,552,400	
Real Estate	100,920	
Supervisory & Administrative (6%)	333,144	
PED (9%)	499,716	
TOTAL FIRST COSTS	$6,486,180	$462,573
O&M	10,072,638	718,348
TOTAL COST	$16,558,818	$1,180,921
Cost Estimate for Alternative D2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$5,563,800	
Real Estate	100,920	
Supervisory & Administrative (6%)	333,828	
PED (9%)	500,742	
TOTAL FIRST COSTS	$6,449,290	$463,508
O&M	10,062,378	717,616
TOTAL COST	$16,561,668	$1,181,124
Cost Estimate for Alternative D3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$5,924,000	
Real Estate	100,920	
Supervisory & Administrative (6%)	355,440	
PED (9%)	533,160	
TOTAL FIRST COSTS	$6,913,520	$493,050
O&M	10,055,257	717,108
TOTAL COST	$16,968,777	$1,210,158
Cost Estimate for Alternative D4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	$6,654,500	
Real Estate	100,920	
Supervisory & Administrative (6%)	39,270	
PED (9%)	598,905	
TOTAL FIRST COSTS	$7,393,595	$527,287
O&M	10,081,771	718,999
TOTAL COST	$17,475,366	$1,246,286

4.9 Environmental Outputs of Alternatives

Two output measures were incorporated into the economic analyses to evaluate the efficiency and effectiveness of the 16 alternatives at achieving environmental restoration objectives: (1) aquatic habitat units; and (2) riparian habitat units. Aquatic habitat units were measured using a model developed for the Jackson Hole study for fine-spotted-cutthroat trout. Riparian habitat units were measured using the USFWS's Habitat Evaluation Procedures palustrine/forest model for the song sparrow. The habitat evaluations indicated significant historic declines in both aquatic and riparian habitat quantity and quality since the 1950s. The habitat evaluations also predicted continued sustained declines in habitat over the 50-year period evaluated.

Table 4.13 - Aquatic Habitat Trends 1998-2050 Without Project

Site	Aquatic Habitat Units				
	1998	*2000*	*2025*	*2050*	*% Change*
Area 1	1,780	1,780	1,739	1,673	(-6%)
Area 4	4,303	4,303	4,181	4,005	(-7%)
Area 9	2,250	2,250	2,190	2,102	(-7%)
Area 10	3,150	3,150	3,067	2,935	(-7%)
All Sites	11,483	11,483	11,177	10,715	(-7%)

Table 4.14 - Riparian Habitat Trends 1998-2050 Without Project

Site	Riparian Habitat Units				
	1998	*2000*	*2025*	*2050*	*% Change*
Area 1	126.9	123.8	85.2	51.2	(-60%)
Area 4	107.8	105.2	72.2	43.1	(-60%)
Area 9	12.7	12.4	8.6	5.3	(-58%)
Area 10	50.6	49.4	34.4	21.2	(-58%)
All Sites	298.0	290.8	200.4	120.8	(-59%)

For each environmental variable, habitat units were estimated for each year in the 50-year period of analysis. The resulting stream of environmental outputs were summed to provide the total output stream with the project, and then divided by the number of years in the period of analysis

(50) to arrive at average annual habitat units for each alternative. The change in habitat units between the without- and with-project conditions was computed for each alternative to be used as the environmental input for the cost effectiveness and incremental cost analyses. The results of these calculations are summarized in the following tables. For each project area (Project Area 1 = Alternative A; Project Area 4 = Alternative B; Project Area 9 = Alternative C; Project Area 10 = Alternative D) data is provided for alternatives 1 through 4, as wall as for the No-Action Alternative (A0, B0, C0, and D0).

Calculations were also conducted to identify the percentage change in habitat units for all alternatives. While the absolute change in habitat figures (column marked "Change") gives the appearance that aquatic benefits are much greater than riparian, the "% Change" figures indicate that in many cases, relative riparian change from the without-project condition is actually greater. The reader is reminded that the two output habitat unit categories were evaluated using different models and, therefore, the habitat units are not directly comparable with one another.

Table 4.15 – Aquatic Habitat Units

Alternative	Without-Project Average Annual Habitat Units	With-Project Average Annual Habitat Units	Change	% Change
A0	1,740.68	1,740.68	00.00	0.0000%
A1	1,740.68	1,786.72	46.04	2.6449%
A2	1,740.68	1,786.72	46.04	2.6449%
A3	1,740.68	1,786.72	46.04	2.6449%
A4	1,740.68	1,786.72	46.04	2.6449%
B0	4,188.8	4,188.8	00.00	0.0000%
B1	4,188.8	4,351.96	163.16	3.8951%
B2	4,188.8	4,351.96	163.16	3.8951%
B3	4,188.8	4,663.96	475.16	11.3436%
B4	4,188.8	4663.96	475.16	11.3436%
C0	2,193.62	2,193.62	00.00	0.0000%
C1	2,193.62	2,317.2	123.58	5.6336%
C2	2,193.62	2,317.2	123.58	5.6336%
C3	2,193.62	2,785.68	592.06	26.9901%
C4	2,193.62	2,785.68	592.06	26.9901%
D0	3,070.52	3,070.52	00.00	0.0000%
D1	3,070.52	3,262.32	191.8	6.2465%
D2	3,070.52	3,262.32	191.8	6.2465%
D3	3,070.52	4,042.8	972.28	31.6650%
D4	3,070.52	4,042.8	972.28	31.6650%

Table 4.16 – Riparian Habitat Units				
Alternative	Without-Project Average Annual Habitat Units	With-Project Average Annual Habitat Units	Change	% Change
A0	89.08	89.08	0.00	0%
A1	89.08	185.63	96.54	108%
A2	89.08	191.69	102.61	115%
A3	89.08	225.78	136.70	153%
A4	89.08	225.78	136.70	153%
B0	75.47	74.57	0.00	0%
B1	75.47	106.07	30.60	41%
B2	75.47	109.83	34.36	46%
B3	75.47	128.56	53.09	70%
B4	75.47	128.56	53.09	70%
C0	12.73	12.73	0.00	0%
C1	12.73	13.89	1.16	9%
C2	12.73	14.36	1.64	13%
C3	12.73	16.85	4.12	32%
C4	12.73	16.85	4.12	32%
D0	35.87	35.87	0.00	0%
D1	35.87	58.70	22.82	64%
D2	35.87	60.70	24.82	69%
D3	35.87	71.26	35.38	99%
D4	35.87	71.26	35.38	99%

4.10 Incidental Benefits

Incidental benefits are anticipated to result from the implementation of restoration measures at the sites. These benefits have not been quantified as part of the study, but are identified here to support informed decision making. Anticipated incidental benefits include recreation benefits, flood control benefits, and reductions in existing operation and maintenance requirements for the existing flood control levee system in the proposed project area. Without further analysis and quantification of these incidental benefits, it is assumed that the benefits consistently result from each of the 16 alternatives.

a. <u>Recreation</u>. Potential incidental recreation benefits include higher-valued recreation experiences and opportunities in the proposed project area, including rafting and boating as well as recreational fishing. Increased fishing opportunities in the area are not expected to be in conflict with the project purpose of environmental restoration. Prevailing fishery management practices include slot limits to allow takings from only portions of the stocks which are in

abundance, and the prevailing culture of recreational fisherman supports catch-and-release practices to support minimization of human impacts. Quantification of incidental recreation benefits for each alternative would require further study.

b. Flood Control. It is expected that the restoration measures under consideration have no significant impacts on flood control benefits provided by the existing Federal flood control project. It is anticipated that there may be small localized flood control benefits in the immediate vicinity of project sites resulting from increased channel capacity from gravel removal. Quantification of incidental localized flood control benefits for each alternative would require further study.

c. Operation and Maintenance. It is anticipated that implementation of restoration features will have the incidental effect of reducing existing O&M expenditures for the existing Federal levee system. Currently, low-flow channels can impinge on the inside of the levees, requiring the placement of armoring to protect the levees form erosion. Because the restoration features propose to train the river away from the levees, it is expected that reductions in O&M requirements will result. Quantification of incidental reductions in O&M costs for the existing Federal flood control project for each alternative would require further study.

4.11 Cost Effectiveness and Incremental Cost Analyses

The cost and output information presented in the previous two sections is the input for cost effectiveness and incremental cost analyses to evaluate the relative effectiveness and efficiency of the different alternatives at producing environmental outputs. Because two different and incommensurate output measures (aquatic and riparian habitat units) were required to assess the holistic effect of alternatives at restoring diverse ecosystem values, two separate analyses were conducted. Each analysis examines the production efficiency of the alternatives for each environmental output category. Following the presentation of results for each environmental category, a comparison is made to identify alternatives that exhibit exceptional performance for both output categories.

To conduct the analyses, the procedures identified in the Corps procedures manual for conducting cost effectiveness and incremental cost analyses (*IWR Report #95-R-1*, USACE, May 1995) were followed. These steps include: (1) display costs and outputs of alternatives; (2)

identify combinable alternatives; (3) derive combinations and calculate costs and outputs; (4) identify cost-effective plans; (5) calculate and display most efficient alternatives through incremental cost analysis. To facilitate the analysis, the Corps software program, IWR-PLAN was used to perform the above steps. The results of the steps are summarized below. First, the analysis for aquatic habitat is presented, followed by the analysis for riparian habitat.

4.11.1 Aquatic Habitat Cost Effectiveness and Incremental Cost Analyses

Table 4.17 provides a display of the costs and outputs associated with each alternative. Both cost and output data are presented as "Average Annual."

Table 4.17 – Aquatic Habitat: Costs and Outputs for All Alternatives

Alternative	Average Annual Cost ($)	Average Annual Aquatic Habitat Units
A0	$0	0.00
A1	815,441	46.04
A2	813,678	46.04
A3	818,574	46.04
A4	907,697	46.04
B0	0	0.00
B1	2,013,260	163.16
B2	2,011,749	163.16
B3	2,025,847	475.16
B4	2,095,316	475.16
C0	0	0.00
C1	444,548	123.58
C2	431,979	123.58
C3	458,836	592.06
C4	466,787	592.06
D0	0	0.00
D1	1,180,921	191.80
D2	1,181,124	191.80
D3	1,210,158	972.28
D4	1,246,286	972.28

The IWR-PLAN software was used to formulate all possible combinations of alternatives for restoring aquatic habitat, resulting in 625 possible combinations of alternatives called plans (including the no-action plan). Cost effectiveness analysis was next performed to identify those combinations of alternatives that (1) produce the same output as other combinations for less cost,

or (2) produce more output than others at the same or less cost. The result was the reduction of the 625 possible combinations to 10 cost-effective combinations (including the no-action plan). Table 4.18 displays the cost-effective plans with their costs and outputs.

Table 4.18 – Aquatic Habitat: Cost-Effective Combinations		
Plan	**Cost ($)**	**Output**
A0+B0+C0+D0	$0	0
A0+B0+C1+D0	431,979	123.58
A0+B0+C3+D0	458,836	592.06
A0+B0+C0+D3	1,210,158	972.28
A0+B0+C1+D3	1,642,137	1,095.86
A0+B0+C3+D3	1,668,994	1,564.34
A2+B0+C3+D3	2,482,672	1,610.38
A0+B2+C3+D3	3,680,743	1,727.50
A0+B3+C3+D3	3,694,841	2,039.50
A2+B3+C3+D3	4,508,519	2,085.54

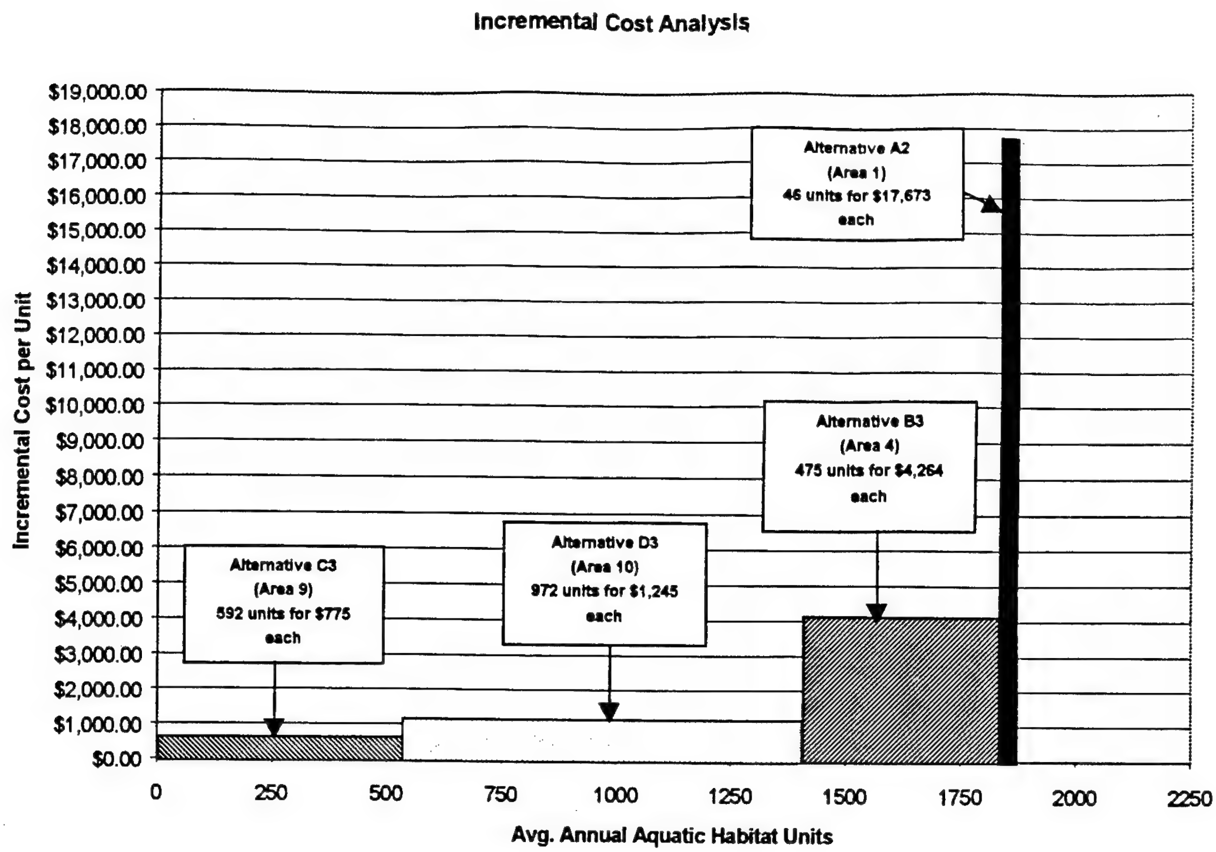
An incremental cost analysis was then conducted to evaluate the changes in cost and output from the no-action plan to all other cost-effective plans. The change in cost associated with each plan was divided by the change in output to determine the incremental cost per unit. The incremental cost per unit reflects the unit cost of providing additional output over the no-action plan. The plan that is identified as having the lowest unit cost of providing additional habitat is sometimes called the best-buy. This best-buy becomes the new baseline to which all larger-output-producing plans are compared to identify the next-best-buy. This iterative process results in the identification of the most efficient set of plans for producing increasing levels of output. The incremental cost analysis identified five best-buy plans (including the no-action plan).

Table 4.19 – Aquatic Habitat: Incremental Cost Analysis (Best-Buys)

Plan	Cost ($)	Output	Change in Cost ($)	Change in Output	Incremental Cost per Unit ($)
A0+B0+C0+D0	$0.00	0	--	--	--
A0+B0+C3+D0	458,836.00	592.06	$458,836.00	592.06	$775
A0+B0+C0+D3	1,668,994.00	1,564.34	1,210,158.00	972.28	1,245
A0+B3+C3+D3	3,694,841.00	2,039.50	2,025,847.00	475.16	4,264
A2+B3+C3+D3	4,508,519.00	2,085.54	813,678.00	46.04	17,673

The data in Table 4.19 can be interpreted to support the recommendation of a plan for producing aquatic habitat. If aquatic habitat units are desired, the most efficient alternative available is C3, which provides 592 average annual habitat units at a unit cost of $775 each. If more output is desired, the next most efficient alternative is to add D3, which provides 972.28 additional average annual habitat units at a unit cost of $1,245 each. If more output is desired, the next most efficient alternative is to add B3, which provides 475 additional average annual habitat units at a unit cost of $4,264 each. If more output is desired, the next most efficient alternative is to add A2, which provides 46 additional average annual habitat units at a unit cost of $17,673 each.

The following figure provides a graphical representation of the data in Table 4.19. Incremental cost per unit is plotted on the vertical axis and output along the horizontal axis. The graph shows relatively small increases in incremental cost per unit from the first alternative (C3) to the next (D3). The increase in incremental cost per unit is larger from D3 to B3, but not as large as the jump in cost to get the last 46 units of output provided by A2.



4.11.2 Riparian Habitat Cost Effectiveness and Incremental Cost Analyses

Table 4.20 provides a display of the costs and outputs associated with each alternative. Both cost and output data are presented as "Average Annual."

Table 4.20 – Riparian Habitat: Costs and Outputs for All Alternatives		
Alternative	**Average Annual Cost ($)**	**Average Annual Riparian Habitat Units**
A0	$0	0.00
A1	815,441	96.54
A2	813,678	102.61
A3	818,574	136.70
A4	907,697	136.70
B0	0	0.00
B1	2,013,260	30.60
B2	2,011,749	34.36
B3	2,025,847	53.09
B4	2,095,316	53.09
C0	0	0.00
C1	444,548	1.16
C2	431,979	1.64
C3	458,836	4.12
C4	466,787	4.12
D0	0	0.00
D1	1,180,921	22.82
D2	1,181,124	24.82
D3	1,210,158	35.38
D4	1,246,286	35.38

The IWR-PLAN software was used to formulate all possible combinations of alternatives for restoring riparian habitat, resulting in 625 possible combinations of alternatives called plans (including the no-action plan). Cost effectiveness analysis was next performed to identify those combinations of alternatives that (1) produce the same output as other combinations for less cost, or (2) produce more output than others at the same or less cost. The result was the reduction of the 625 possible combinations to 26 cost-effective combinations (including the no-action plan). Table 4.21 displays the cost-effective plans with their costs and outputs.

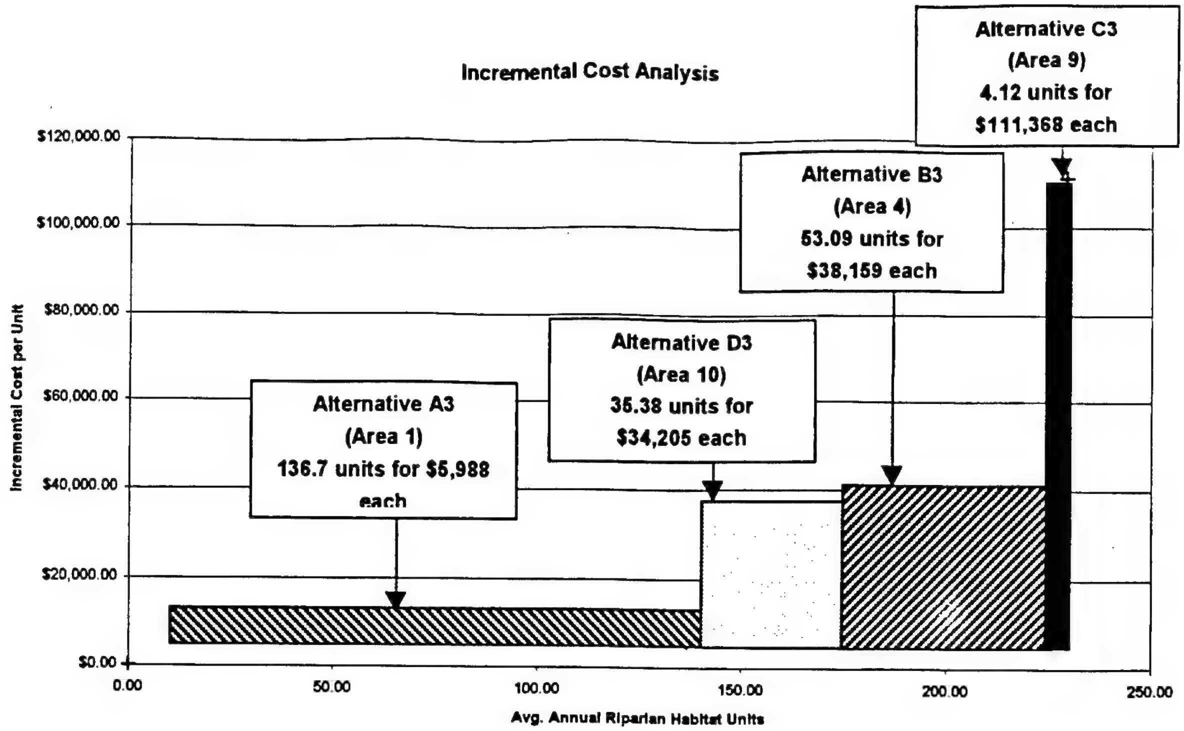
Table 4.21 – Riparian Habitat - Cost Effective Combinations		
Plan	**Cost $**	**Output**
A0+B0+C0+D0	$0	0.00
A0+B0+C2+D0	431,979	1.64
A0+B0+C3+D0	458,836	4.12
A2+B0+C0+D0	813,678	102.61
A3+B0+C0+D0	818,574	136.70
A3+B0+C2+D0	1,250,553	138.34
A3+B0+C3+D0	1,277,410	140.82
A3+B0+C0+D1	1,999,495	159.52
A3+B0+C0+D2	1,999,698	161.52
A3+B0+C0+D3	2,028,732	172.08
A3+B0+C2+D3	2,460,711	173.72
A3+B0+C3+D3	2,487,568	176.20
A3+B3+C0+D0	2,844,421	189.79
A3+B3+C2+D0	3,276,400	191.43
A3+B3+C3+D0	3,303,257	193.91
A3+B2+C0+D2	4,011,447	195.88
A3+B3+C0+D1	4,025,342	212.61
A3+B3+C0+D2	4,025,545	214.61
A3+B3+C0+D3	4,054,579	225.17
A3+B3+C2+D3	4,486,558	226.81
A3+B3+C3+D3	4,513,415	229.29

An incremental cost analysis was then conducted to evaluate the changes in cost and output from the no-action plan to all other cost-effective plans. The change in cost associated with each plan was divided by the change in output to determine the incremental cost per unit. The incremental cost per unit reflects the unit cost of providing additional output over the no-action plan. The plan that is identified as having the lowest unit cost of providing additional habitat is sometimes called the best-buy. This best-buy becomes the new baseline to which all larger-output-producing plans are compared to identify the next-best-buy. This iterative process results in the identification of the most efficient set of plans for producing increasing levels of output. The incremental cost analysis identified five best-buy plans (including the no-action plan).

Table 4.22 – Riparian Habitat: Incremental Cost Analysis (Best-Buys)					
Plan	**Cost ($)**	**Output**	**Change in Cost ($)**	**Change in Output**	**Incremental Cost per Unit ($)**
A0+B0+C0+D0	$0	0.00	--	--	--
A3+B0+C0+D0	818,574	136.70	$818,574	136.70	$5,988
A3+B0+C0+D3	2,028,732	172.08	1,210,158	35.38	34,205
A3+B3+C0+D3	4,054,579	225.17	2,025,847	53.09	38,159
A3+B3+C3+D3	4,513,415	229.29	458,836	4.12	111,368

The data in Table 4.22 can be interpreted to support the recommendation of a plan for producing riparian habitat. If riparian habitat units are desired, the most efficient alternative available is A3, which provides 136.70 average annual habitat units at a unit cost of $5,988 each. If more output is desired, the next most efficient alternative is to add D3, which provides 35.38 additional average annual habitat units at a unit cost of $34,205 each. If more output is desired, the next most efficient alternative is to add B3, which provides 53.09 additional average annual habitat units at a unit cost of $38,159 each. If more output is desired, the next most efficient alternative is to add C3, which provides 4.12 additional average annual habitat units at a unit cost of $111,368 each.

The figure on the following page provides a graphical representation of the data in Table 4.22. Incremental cost per unit is plotted on the vertical axis and output along the horizontal axis. The graph shows a large return for investment with A3 (Area 1), then a jump in incremental cost per unit to get to the next alternatives (B3 and D3), which each provide significant output for similar incremental cost per unit. A significant increase in incremental cost per unit comes as Alternative C3 is implemented. This is largely due to the relatively small change in riparian output with the alternative. While C3 ranks last in riparian habitat production efficiency, this is in large part due to the riparian habitat demonstration project that has already been completed at Area 9 and factored into the without-project analysis. Further examination should be conducted to determine if implementing the aquatic habitat restoration features at Area 9 would provide for sustainability of benefits to be provided by the Area 9 demonstration project.



4.12 Cross-Comparison of Aquatic and Riparian Costs and Benefits

Because the project required two analyses, one for aquatic restoration and one for riparian restoration, a comparison of results was conducted to identify any plans that may be particularly effective and efficient at producing both types of outputs. This comparison is summarized in Table 4.23. Table 4.23 lists the alternatives that were found to be best-buys for either output type. For each alternative, cost, aquatic habitat units, riparian habitat units, and incremental cost per unit for both habitat types are presented. In addition the table indicates whether each alternative was found to be (1) cost-effective for either habitat type, and (2) a best-buy for either habitat type. In the columns that identify if alternatives were determined to be best-buys, a number in parentheses indicates the rank of the best-buy. For example, a 1 indicates that the alternative was the most efficient at producing that output type, a 2 was the next most efficient, and so on.

Table 4.23 – Cross-Comparison of Aquatic and Riparian Costs and Benefits

Evaluation Criteria	Alternative				
	D3 (Area 10)	B3 (Area 4)	C3 (Area 9)	A3(1) (Area 1)	A2(1) (Area 1)
Avg. Annual Cost	$1,210,158	$2,025,847	$458,836	$818,574	$813,678
Avg. Annual Aquatic Output	972.28	475.16	592.00	46.04	46.04
Inc. Cost per Unit of Aquatic	$1,244	$4,263	$775	–	$17,673
Avg. Annual Riparian Output	35.38	53.09	4.12	136.70	102.61
Inc. Cost per Unit of Riparian	$34,205	$38,159	$111,368	$5,988	–
Cost-Effective for Aquatic	X	X	X		X
Cost-Effective for Riparian	X	X	X	X	
Best-Buy for Aquatic (Rank out of 4)	X(2)	X(3)	X(1)	–	X(4)
Best-Buy for Riparian (Rank out of 4)	X(2)	X(3)	X(4)	X(1)	–

(1) Alternative A3 was identified as the first best-buy for riparian but was found to be non-cost effective for aquatic because A2 provided the same aquatic output as A3 for approximately $5,000 less. Due to the closeness in cost of A3 and A2, and A2s A2 is set aside and A3 is carried forward for possible recommendation.

4.13 Uncertainty Analysis

To examine the effect of uncertainty in cost and output estimates, an analysis was conducted that evaluated the implications of 20 percent uncertainty in cost estimates and 20 percent uncertainty in output estimates. All cost and output estimates for all 625 possible combinations were adjusted to reflect plus and minus 20 percent. A best-case scenario using the minus 20 percent adjusted cost estimates and the plus 20 percent adjusted output estimates was then analyzed for both aquatic and riparian output types. Similarly, a worst-case scenario was analyzed using plus 20 percent adjusted cost estimates and minus 20 percent adjusted output estimates. The results of these sensitivity analyses provided very similar results to those presented in the previous sections. In both the best- and worst-case scenarios, the ranking of best-buys was the same as described in the previous section, indicating that data uncertainty in the plus or minus 20 percent range should not have a significant impact on the results.

4.14 Initially Proposed NER Plan Recommendation

(See also Section 4.16 for a progressive approach.)

Based upon the cost effectiveness and incremental cost analyses and the comparison of aquatic and riparian costs and benefits, Alternative D3 at Area 10 stood out as the most efficient option for producing combined habitat types, ranking second in efficiency for riparian habitat and second for aquatic. Alternative B3 at Area 4 is recommended as it is the third most efficient for riparian and the third most efficient for aquatic. Alternative A3 at Area 1 is clearly the most efficient for riparian but is the least efficient for aquatic. Similarly, Alternative C3 at Area 9 is the most efficient for aquatic although it is the least efficient for riparian. Both these sites are recommended for incorporation into a holistic ecosystem restoration plan for the study area based upon the results of the cost effectiveness analysis. The economic analysis supports the recommendation of plan A3+B3+C3+D3 as the initially proposed National Ecosystem Restoration Plan (NER Plan) for the Jackson Hole study. This plan corresponds to Area 1, 50-year fence design (piling), Area 4, 50-year fence design (piling), Area 9, 50-year fence design (piling), and Area 10, 50-year fence design (piling). Table 4.24 summarizes the information on the initially proposed NER Plan.

Table 4.24 – Initially Proposed NER Plan Cost and Output Summary

Alternative		Total Cost ($)	Average Annual Cost ($)	Total O&M (included in Total Cost) ($)	Average Annual O&M Cost (included in Avg. Annual Cost) ($)	Total Real Estate Cost (included in Total Cost) ($)	Average Annual Aquatic Output	Average Annual Riparian Output
A3	Area 1, 50-year fence design (piling)	$11,478,009	$818,574	$5,676,584	$404,836	$286,140	46.04	136.7
B3	Area 4, 50-year fence design (piling)	28,406,327	2,025,847	15,557,362	1,109,501	99,720	475.16	53.09
C3	Area 9, 50-year fence design (piling)	6,443,773	458,836	2,855,718	203,661	67,800	592.06	4.12
D3	Area 10, 50-year fence design (piling)	16,968,777	1,210,158	10,055,257	717,108	100,920	972.28	35.38
A3+B3+C3+D3		$63,296,886	$4,513,415	$34,144,921	$2,435,106	$554,580	2,085.54	229.29

As presented in Table 4.24, the NER Plan for the *Feasibility Study* has an estimated total cost of $63,296,886, or an average annual equivalent cost of $4,513,415. This total cost includes $34,144,921 in total O&M costs over the project life (an average annual equivalent value of $2,435,106 per year, and a total real estate cost of $554,580. The plan is estimated to provide an additional 2,086 aquatic habitat units over the without-project condition (an increase 18.5 percent from the without-project condition). The plan is also estimated to provide an additional 229 riparian habitat units (an increase of 107.6 percent from the without-project condition).

4.15 Value Engineering / Initially Proposed NER Plan Refinement

Following identification of the initially proposed NER Plan, the Walla Walla District and the sponsor agreed with the recommendation and also with the need to evaluate opportunities to refine the project and O&M procedures in areas that may lead to cost savings without reducing project performance. In response, the Walla Walla District study team conducted a value engineering exercise to refine the plan's preliminary cost estimate and examine, identify, and incorporate cost savings into project construction, operation and maintenance. This section identifies the changes to the NER Plan resulting in cost savings and evaluates the impact of such changes on plan formulation.

Savings were identified in three primary areas:

- Reductions in component quantities.
- Reductions in construction cost.
- Reductions in O&M cost.

4.15.1 Refinement of Quantities

The NER Plan includes restoration alternatives for Areas 1, 4, 9, and 10 (see Plates 4, 16 through 19). Plan elements include gravel removal, site armoring, piling eco-fence, anchored root wads, and riprap structures such as kickers, bank barbs, and grade controls. Approximate quantities for the major components of the NER Plan are summarized in Table 4.25. Changes in quantities from those used in the preliminary estimate to those used in the refined estimate are indicated in the table.

As indicated in the table, the major reductions in quantities come in the area of gravel removal estimated to be required for excavation of sediment traps and stabilization of the channel. There is a net decrease (across all sites) in the quantities required for armoring and spur dikes. Quantities estimated for eco-fences, anchored root wads, and rock grade control are not changed in the refined estimates.

Table 4.25 – Initially Proposed NER Plan Quantities Refinement

Location	Quantity Estimate	Gravel Removal	Armoring	Eco-Fences	Root Wads	Spur Dikes	Rock Grade Control
Area 1	Preliminary	419,400	46,600	7,600	440	0	0
	Refined	334,000	66,800	7,600	440	200	0
	Change	-85,400	20,200	0	0	200	0
Area 4	Preliminary	1,062,790	118,080	6,100	320	1,700	0
	Refined	371,800	74,360	6,100	320	200	0
	Change	-690,990	-43,720	0	0	-1,500	0
Area 9	Preliminary	234,000	26,000	650	250	2,550	3,300
	Refined	130,000	26,000	650	250	2,550	3,300
	Change	-104,000	0	0	0	0	0
Area 10	Preliminary	528,530	58,730	4,800	180	4,250	0
	Refined	293,600	58,730	4,800	180	4,250	0
	Change	-234,930	0	0	0	0	0

4.15.2 Refinement of Unit Costs

All reductions in unit costs in the refined cost estimates are attributable to the identification of a closer disposal site for dredged material. Initial cost estimates for disposal of dredged material were based upon use of a disposal site located approximately 12 miles from the proposed project sites. A closer disposal facility was identified approximately 5 miles from the project sites, reducing disposal costs. Other unit costs remained unchanged from the preliminary estimates.

4.15.3 Refinement of Operation and Maintenance Costs

Due to concerns about the high cost of annual maintenance following initial construction of the project, the requirements for gravel removal were revisited. The preliminary estimates reflected

the maximum reasonable expected requirements based upon the available information at that time. Subsequent sediment range resurveys indicated that the actual gravel requirement is likely much less than the original estimate (reflected in the refinement of construction quantities, Section 4.15.1) and may be zero after some years at one or more of the proposed restoration sites. Based upon this new information, the costs for removal of gravel for channel capacity and sediment traps was reduced to more accurately reflect actual expected values over the project life. This reduction in annual maintenance requirements resulted in significant cost corrections for project operation and maintenance.

Table 4.26 – Refined O&M Quantities

			Annual O&M Percentage		Annual O&M Quantities	
		Construction Quantity	Years 1-5	Years 6-50	Years 1-5	Years 6-50
AREA 1	Gravel removal	334,000	13%	7%	43,420	23,380
	Armoring	66,800	13%	7%	8,684	4,676
	Fences	7,600	2%	4%	152	304
	Root wads	440	20%	20%	88	88
	Spur dikes	200	N/A.	N/A.	N/A.	N/A.
	Rock grade control	0	13%	14%	0	0
			Annual O&M Percentage		Annual O&M Quantities	
		Construction Quantity	Years 1-5	Years 6-50	Years 1-5	Years 6-50
AREA 4	Gravel removal	371,800	13%	9%	48,334	33,462
	Armoring	74,360	13%	9%	9,667	6,692
	Fences	6,100	2%	4%	122	244
	Root wads	320	20%	20%	64	64
	Spur dikes	200	N/A	N/A	N/A	N/A
	Rock grade control	0	13%	14%	0	0
			Annual O&M Percentage		Annual O&M Quantities	
		Construction Quantity	Years 1-5	Years 6-50	Years 1-5	Years 6-50
AREA 9	Gravel removal	130,000	13%	5%	16,900	6,500
	Armoring	26,000	13%	5%	3,380	1,300
	Fences	650	2%	4%	13	26
	Root wads	250	20%	20%	50	50
	Spur dikes	2,550	N/A	N/A	N/A	N/A
	Rock grade control	3,300	13%	14%	429	462
			Annual O&M Percentage		Annual O&M Quantities	
		Construction Quantity	Years 1-5	Years 6-50	Years 1-5	Years 6-50
AREA 10	Gravel removal	293,600	13%	10%	38,168	29,360
	Armoring	58,730	13%	10%	7,635	5,873
	Fences	4,800	2%	4%	96	192
	Root wads	180	20%	20%	36	36
	Spur dikes	4,250	N/A	N/A	N/A	N/A
	Rock grade control	0	13%	14%	0	0

4.15.4 Summary of Initially Proposed NER Plan Refined Costs

Table 4.26 presents the effects on summary cost categories of the value engineering cost refinements in the areas of construction quantities, unit costs, and O&M quantities.

Table 4.26.A – Initially Proposed NER Plan Refined Cost Estimate Summary					
Alternative		First Cost (Construction, Real Estate, PED, S&A)	O&M	Total Cost	Average Annual Cost
A3	Area 1, 50-year fence design (piling)	8,083,000	2,515,194	10,598,194	755,829
B3	Area 4, 50-year fence design (piling)	8,616,000	2,967,328	11,583,328	826,085
C3	Area 9, 50-year fence design (piling)	3,417,000	1,061,610	4,478,610	319,400
D3	Area 10, 50-year fence design (piling)	6,858,000	2,353,597	9,211,597	656,941
A3+B3+C3+D3		26,974,000	8,897,729	35,871,729	2,558,255

Table 4.26.B – Initially Proposed NER Plan Preliminary Cost Estimate Summary					
Alternative		First Cost (Construction, Real Estate, PED, S&A)	O&M	Total Cost	Average Annual Cost
A3	Area 1, 50-year fence design (piling)	5,801,425	5,676,584	11,478,009	818,574
B3	Area 4, 50-year fence design (piling)	12,848,965	15,557,362	28,406,327	2,025,847
C3	Area 9, 50-year fence design (piling)	3,588,055	2,855,718	6,443,773	458,836
D3	Area 10, 50-year fence design (piling)	6,913,520	10,055,257	16,968,777	1,210,158
A3+B3+C3+D3		29,151,965	34,144,921	63,296,886	4,513,415

Table 4.26.C – Change in Cost Estimates Summary					
Alternative		First Cost (Construction, Real Estate, PED, S&A)	O&M	Total Cost	Average Annual Cost
A3	Area 1, 50-year fence design (piling)	+ $2,281,575	- $3,161,390	- $879,815	- $62,745
B3	Area 4, 50-year fence design (piling)	-4,232,965	-12,590,034	-16,822,999	-1,199,762
C3	Area 9, 50-year fence design (piling)	-171,055	-1,794,108	-1,965,163	-139,436
D3	Area 10, 50-year fence design (piling)	-55,520	-7,701,660	-7,757,180	-553,217
A3+B3+C3+D3		- $2,177,965	- $25,247,192	- $27,425,157	- $1,955,160

Table 4.26.A summarizes the refined cost estimates for each component of the NER Plan as well as for the NER Plan as a whole. Table 4.26.B summarizes the cost estimates described in

Section 4, Plan Formulation. Table 4.26.C summarizes the change in cost from the preliminary estimates to the refined estimates. Table 4.26.C shows the reductions in each cost component for the NER Plan to be as follows:

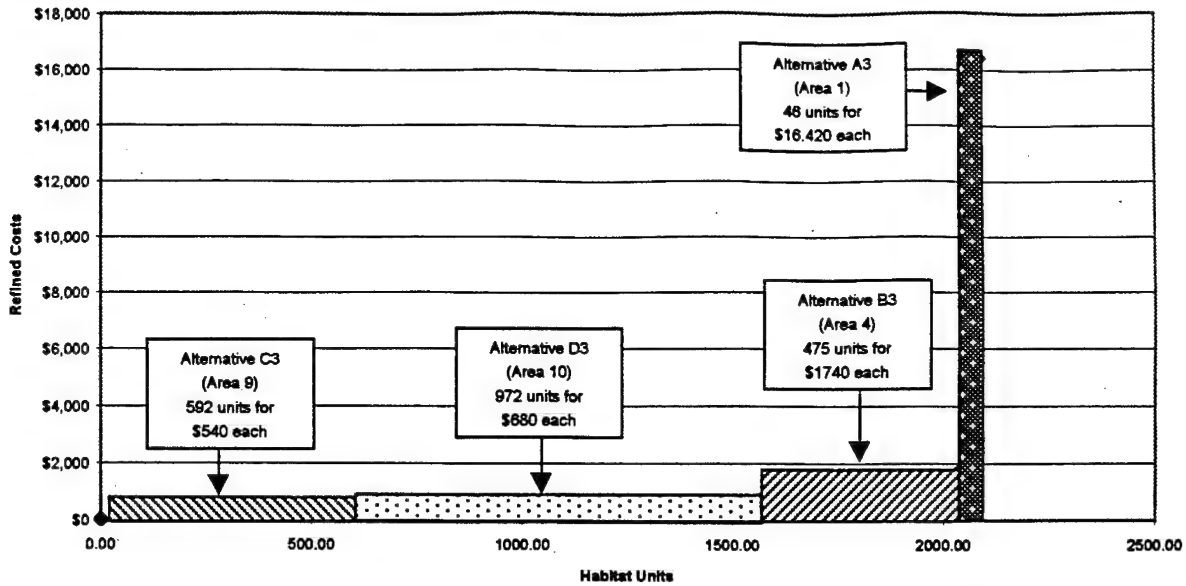
- Construction, PED, and Supervisory/Administrative changed by -$2,177,965.
- O&M Costs changed by -$25,247,192.
- Total Costs changed by -$27,425,157.
- The average annual equivalent value of total costs changed by -$1,955,160 per year.

4.15.5 Impact of Cost Reductions on Plan Formulation

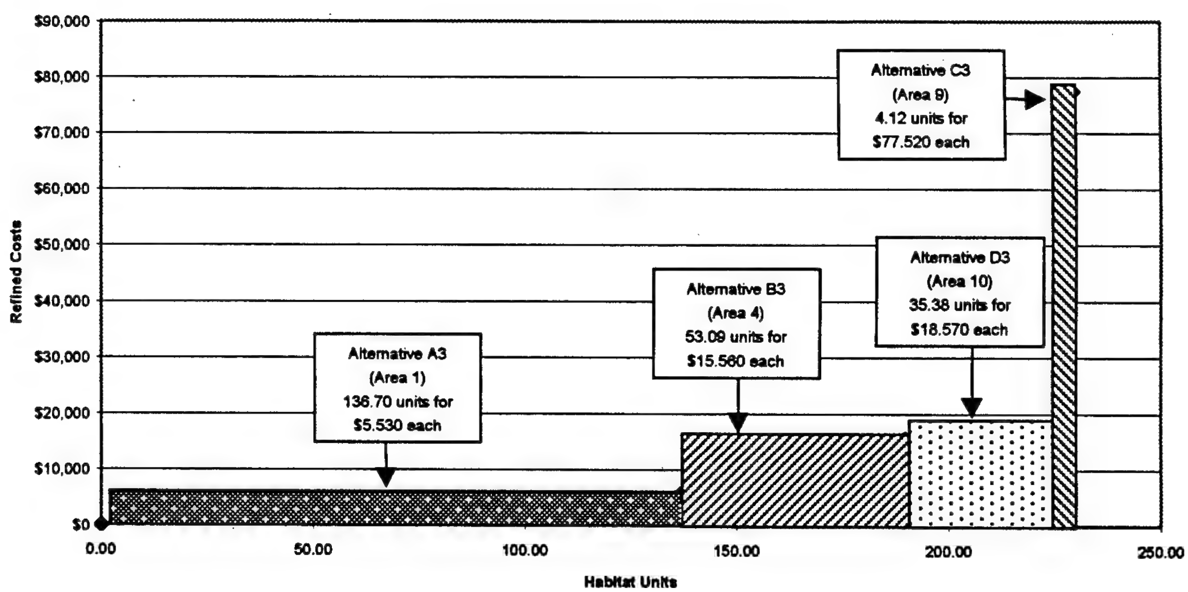
Because of the significant reductions in the initially proposed NER Plan's cost (as identified in Section 4.15.4) the study team assessed the impacts of the refined costs on the plan formulation process documented in earlier parts of Section 4. It was determined that the cost reductions would have no impact on the selection of Design Alternative 3 (differentiated by the 50-year piling eco-fence) at each of the sites because the cost reductions would apply consistently to all alternatives at each site. Therefore, the rationale for selecting Alternative 3 at each site would hold in a new cost effectiveness and incremental cost evaluation.

However, the reductions in cost were determined to have differing impacts on the different study areas (for example, a significant change in construction costs was tied to the identification of a closer site for disposal of dredged material. As some study areas require more excavation than others, this change would affect different sites inconsistently. To assess the impact on formulation of the NER Plan, an analysis was conducted to determine the relative cost effectiveness of the individual components of the NER plan (A3, B3, C3, and D3) with the refined costs estimates. The results of the new incremental cost analyses for each output type (aquatic and riparian) are presented in graphs on the following page. A discussion of the reductions in incremental cost and the impacts on formulation of the NER Plan follow the incremental cost graphs.

Incremental Cost Analysis (Aquatic)



Incremental Cost Analysis (Riparian)



4.15.5.1 Refined Aquatic Cost Analysis

The incremental cost analysis for restoration of aquatic habitat produced the same sequence of recommended components with the refined costs as with the preliminary costs. The amount of output provided remained constant while the incremental cost per unit decreased across the board. As with the earlier analysis using preliminary costs, the most efficient option was identified as C3 (Area 9). Alternative C3 provides 592 habitat units at an annual unit cost of $540 each. This unit cost is down from $775 each with the preliminary estimate. The second most efficient alternative in both analyses (using preliminary and refined estimates) was D3 (Area 10). D3 provides 972 habitat units at an annual unit cost of $680 each (down from the unit cost of $1,245 each with the preliminary cost estimates). Next in the efficiency rankings in both analyses was B3 (Area 4). B3 provides 475 habitat units at an annual unit cost of $1,740 each (down from a unit cost of $4,264 each with the preliminary cost estimates). Ranking last in efficiency for restoring aquatic habitat was Alternative A3 (Area 1), which provides 46 additional habitat units at an annual unit cost of $16,420 each (down from $17,673 with the preliminary cost estimates). The percentage reduction in incremental unit costs are summarized below:

- Area 9 (Alternative C3) — Incremental unit cost reduced by 30 percent.
- Area 10 (Alternative D3) — Incremental unit cost reduced by 45 percent.
- Area 4 (Alternative B3) — Incremental unit cost reduced by 60 percent.
- Area 1 (Alternative A3) — Incremental unit cost reduced by 7 percent.

Based upon these results there is no impact of using the refined costs that changes the results of the formulation of the NER Plan based upon aquatic incremental cost evaluations.

4.15.5.2 Refined Riparian Cost Analysis

The incremental cost analysis for restoration of riparian habitat produced a similar sequence of recommended components with the refined costs as with the preliminary costs. The amount of output provided remained constant while the incremental cost per unit decreased across the board. As with the earlier analysis using preliminary costs, the most efficient option was identified as A3 (Area 1). Alternative A3 provides 136.70 habitat units at an annual unit cost of $5,530 each. This unit cost is down from $5,988 each with the preliminary estimate. The

second most efficient alternative in both analyses (using preliminary and refined estimates) was B3 (Area 4). B3 provides 53.09 habitat units at an annual unit cost of $15,560 each (down from the unit cost of $38,159 each with the preliminary cost estimates). Next in the efficiency rankings in both analyses was D3 (Area 10). D3 provides 35.38 habitat units at an annual unit cost of $18,570 each (down from a unit cost of $34,205 each with the preliminary cost estimates). Ranking last in efficiency for restoring aquatic habitat was Alternative C3 (Area 9), which provides 4.12 additional habitat units at an annual unit cost of $77,520 each (down from $111,368 with the preliminary cost estimates). The percentage reduction in incremental unit costs are summarized below:

- Area 1 (Alternative A3) — Incremental unit cost reduced by 7 percent.
- Area 4 (Alternative B3) — Incremental unit cost reduced by 60 percent.
- Area 9 (Alternative D3) — Incremental unit cost reduced by 45 percent.
- Area 10 (Alternative C3) — Incremental unit cost reduced by 30 percent.

The cost effectiveness rankings of B3 and D3 were reversed, but the relative increase in incremental cost between the two is reasonable and both are recommended. Based upon these results there is no impact of using the refined costs that changes the results of the formulation of the NER plan based upon riparian incremental cost evaluations.

4.16 The Progressive Plan

4.16.1 Plan Recommendation

The Corps conducted this feasibility study of the Snake River near Jackson Hole, Wyoming, from August 1996 to January 2000. An alternative formulation briefing was held in July 1999, and the study results (pending resolution of several issues) were approved for public release with concurrent HQUSACE review. At that time, the proposed project covered approximately 5 miles of the 22-mile stretch of the Snake River that had been authorized for study.

During a site visit in October 1999, Headquarters staff recommended that the District Project Manager consider using the cost and benefit information gathered for the 5-mile study area (presented in this report as the initially proposed NER Plan) as a proxy for the entire 22-mile

reach. The rationale is that the applicable engineering measures had already been identified, the benefits of the management measures had been evaluated, and the construction costs had been developed. Therefore, the District could use the site-specific information to formulate a complete plan to restore the entire degraded area. The complete plan developed by the district is presented as the "Progressive Plan" in this report.

4.16.2 Plan Formulation of the Progressive Plan

At the point that the initially proposed NER Plan was formulated, the feasibility study had conducted five levels of plan refinement: (1) significance based preliminary screening; (2) formulation of initial alternatives; (3) cost effectiveness and incremental cost analyses; (4) uncertainty analysis and value engineering; and (5) NER plan refinement. The sixth level of analysis used to address the entire 22-mile reach of the Snake River is based on the refined cost and benefits of Areas 1, 4, 9, and 10. In order to select restoration tools and features for the Progressive Plan, the study team analyzed recent aerial photographs, floodplain cross-sectional data, and results of the sponsor-constructed demonstration project as represented in the *Final Report: Snake River Restoration Demonstration Project*, prepared by Teton Conservation District (included in the Supplementary Section of this study). Table 4.27 presents the configuration of restoration measures for the Progressive Plan.

Table 4.27 – Configurations of Management Measures by Study Area: Progressive Plan							
	Gravel Removal			Fences	Barbs	Root Wads	Grade Control
	Channel Capacity	Side Pools	Sediment Traps				
Area 1		X	X	X		X	
Area 4	X	X	X	X	X	X	
Area 9	X	X	X	X	X	X	X
Area 10	X	X	X	X	X	X	
Area A	X	X	X	X	X	X	
Area B	X	X	X	X	X	X	
Area C	X	X	X	X	X		
Area D	X	X	X	X	X	X	
Area E	X				X	X	
Area F	X			X	X	X	
Area G	X	X		X	X	X	
Area H	X	X		X	X	X	

In addition, a new project cost estimate was developed based on a progressive project construction and monitoring plan. This approach takes into consideration the complexity of the restoration effort and applies an efficiency curve that represents the anticipated benefits of adaptive management. The progressive estimate assumes that the cumulative knowledge of construction, adaptive management, and monitoring will result in cost reduction. The approach resulted in a significant reduction in total project cost and reduces monitoring costs to 4 percent of the total project cost. The first site constructed would be phased over a 6-year period to allow refinement and fine tuning of restoration features. The construction period would then be reduced for each consecutive area until a three-year construction phase is reached. Table 4.28 illustrates the construction and monitoring phasing and provides project cost by area, and details Federal, non-Federal, and fully funded cost.

JACKSON HOLE ENVIRONMENTAL RESTORATION PROJECT
CONSTRUCTION & MONITORING and COST TIMELINE

Project Cost

KEY: Construction (schedule and cyds): SS — Continuing Construction (schedule and cyds): $$ — Monitoring: $$

Estimated Project Cost based on Construction Schedule

FY	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Areas																					
9	73	2,712											-	-	-	-	-	-	-	-	$ 4,306
			259	267	276	285	294														
1	-	698	6,137										-	-	-	-	-	-	-	-	$ 9,628
				589	608	628	649														
4	-	-	797	6,566									-	-	-	-	-	-	-	-	$ 9,716
					656	678	700														
10	-	-	-	636	5,387								-	-	-	-	-	-	-	-	$ 7,338
						529	547														
B	-	-	-	-	589	5,117								-	-	-	-	-	-	-	$ 6,726
							394	407													
D	-	-	-	-	-	509	4,629								-	-	-	-	-	-	$ 5,799
								232	240												
F	-				-	-	545	4,782								-	-	-	-	-	$ 6,010
									240	248											
A	-				-	-	-	546	3,786								-	-	-	-	$ 5,082
										289	299										
G	-				-	-	-	-	459	3,848								-	-	-	$ 4,855
											192	199									
H	-	-	-	-	-	-	-	-	-	400	2,678										$ 3,454
												131	136								
C	-	-	-	-	-	-	-	-	-	-	294	2,098								-	$ 2,687
													104	106							
E	-	-	-	-	-	-	-	-	-	-	-	213	617								$ 897
														21	22						
Total	$ 73	$ 3,410	$ 7,193	$ 8,058	$ 7,516	$ 7,746	$ 7,758	$ 6,171	$ 4,972	$ 5,070	$ 3,787	$ 2,997	$ 1,041	$ 289	$ 164	$ 107	$ 75	$ 44	$ 22	$ 5	$66,498

Cost Share

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
GOVT	$ 47	$ 2,216	$ 4,675	$ 5,238	$ 4,885	$ 5,035	$ 5,043	$ 4,011	$ 3,232	$ 3,296	$ 2,462	$ 1,948	$ 677	$ 188	$ 106	$ 70	$ 49	$ 28	$ 14	$ 3	
Running Total		$ 2,264	$ 6,939	$ 12,177	$ 17,062	$ 22,097	$ 27,140	$ 31,151	$ 34,383	$ 37,678	$ 40,140	$ 42,088	$ 42,765	$ 42,953	$ 43,059	$ 43,129	$ 43,178	$ 43,206	$ 43,221	$ 43,224	
Sponsor	$ 26	$ 1,193	$ 2,517	$ 2,820	$ 2,631	$ 2,711	$ 2,715	$ 2,160	$ 1,740	$ 1,775	$ 1,326	$ 1,049	$ 364	$ 101	$ 57	$ 38	$ 26	$ 15	$ 8	$ 2	
Running Total		$ 1,219	$ 3,736	$ 6,557	$ 9,187	$ 11,898	$ 14,614	$ 16,773	$ 18,514	$ 20,288	$ 21,614	$ 22,663	$ 23,027	$ 23,129	$ 23,186	$ 23,223	$ 23,250	$ 23,265	$ 23,273	$ 23,274	$66,498

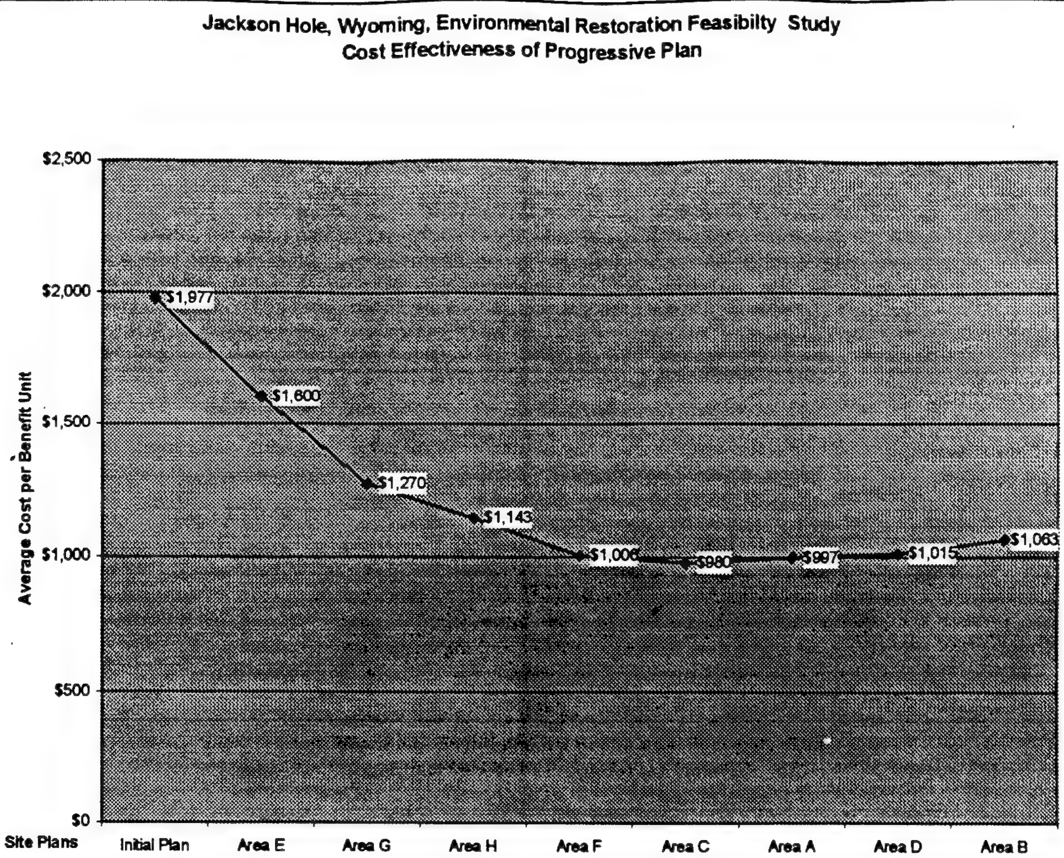
4.16.3 Cost Effectiveness and Incremental Analysis

The IWR-PLAN software was used to formulate all possible combinations of alternatives for restoring aquatic and riparian habitat for the Progressive Plan. Areas A through H were compared with the areas studied in formulation of the initially proposed NER Plan. Cost effective analysis was next performed to identify those combinations of alternatives that produce the same output as other combinations for less cost, or produce more output than others at the same or less cost. Table 4.29 displays the cost-effective alternatives with their costs and outputs. The table illustrates the reduced cost to be realized with the larger, progressive restoration plan.

Table 4.29 – Incremental Analysis: Progressive Plan

	Equivalent Annual Costs ($1,000)	Annual Benefit Units	Average Cost per Benefit Unit ($1,000)	Cumulative Annual Cost ($1,000)	Cumulative Annual Benefit Units	Cumulative Average Cost per Benefit Unit
Initial NER Plan	$4,577	2,315				$1,977
Area E	81	596	$136	$4,658	2,911	1,600
Area G	575	1,209	476	5,233	4,120	1,270
Area H	395	806	490	5,628	4,926	1,143
Area F	747	1,411	529	6,375	6,337	1,006
Area C	300	477	629	6,675	6,814	980
Area A	749	634	1,181	7,424	7,448	997
Area D	737	596	1,237	8,161	8,044	1,015
Area B	1,066	634	1,681	9,227	8,678	1,063

The following figure provides a graphical representation of the data in Table 4.29



4.16.4 Plan Summary

Based upon the cost effectiveness and incremental cost analysis the Progressive Plan is recommended for construction. This plan builds upon the efficiencies gained in the initially proposed NER plan (Areas 1, 4, 9, and10) and leads to greater efficiencies for the remainder of the impacted 22-mile reach of the Snake River. The Progressive Plan reduces average cost per benefit units starting with Area E at $1,600 each to Area G at $1,270, to Area H at $1,143, to Area F at $ 1,006 to Area C at $980 before increasing slightly in Area A to $997, Area D at $1,015 to Area B at $ 1,063 (see Table 4.30). The economic analysis supports the recommendation of the Progressive Plan as the proposed NER Plan for the Jackson Hole study area. Table 4.30 summarizes the information on the proposed Progressive Plan.

Table 4.30-Progressive Plan Cost and Output Summary (2001 dollars)

($1,000)

Alternative	TPC Total Construction Cost (2001 Base Year)	IDC	TIC	Annual Investment Costs	Annual O&M Costs	Total Annual Costs	Average Annual Aquatic Outpug	Average Annual Riparian Output
A3 Area 1	$8,839	$2,609	$11,448	$737	$586	$1,323	46.04	136.70
B3 Area 4	8,706	2,003	10,709	698	789	1,487	475.16	53.09
C3 Area 9	4,029	1,419	5,448	344	217	561	592.06	4.12
D3 Area 10	6,412	1,068	7,480	493	714	1,207	972.28	35.38
Area A	3,909	672	4,581	303	446	749	570.19	63.71
Area B	5,698	967	6,665	440	626	1,066	570.19	63.71
Area C	1,880	331	2,211	147	153	300	473.65	3.30
Area D	4,767	828	5,595	370	367	737	592.06	4.12
Area E	613	117	730	49	32	81	592.06	4.12
Area F	4,783	832	5,615	372	375	747	1361.19	49.53
Area G	3,620	631	4,251	282	293	575	1166.73	42.46
Area H	2,495	441	2,936	195	200	395	777.82	28.30
Total NER Plan	$55,751	$11,917	$67,668	$4,429	$4,797	$9,227	8,189.40	488.50

Definitions: Base Budget Year = 2001, price level at October 1, 2000.
TPC = Total Project Cost = Construction costs, lands, PED, construction management, and monitoring costs.
IDC = Interest During Construction = Time value of construction investment dollars.
Total Annual Costs = AAE Costs = Amortized present value of lifetime costs at discount rate of 6.875%, over 50 year project life and/or total average annual equivalent cost of total investment and total O&M costs.
Annual Benefit Output over project life of 50 years for both aquatic and riparian units.
Total may not be exact due to rounding.

5. DESCRIPTION OF INITIALLY PROPOSED NER PLAN AND THE PROGRESSIVE NER PLAN

5.1 NER Plan Benefits Simulation

The overall effect of the proposed NER Plan is best shown in the computer-generated oblique aerial views of the without- and with-project conditions at Area 9. Plate 20 shows the existing condition (looking downstream) of the Snake River between the levees. The channel is largely devoid of vegetation, which is confined to islands located near the left bank levee. In the future, without-project condition (Plate 21) the flows between the levees will continue to rework the gravels in the channel and will remove all but a few very small remnants of the currently existing islands.

Plate 22 shows the with-project condition immediately after construction. Here eco-fences are placed on the right side of the vegetated island to the left-center of the view and anchored root wads are placed on the upstream edges of the unvegetated island in the center of the view. Channel capacity excavations are visible in the main channel and secondary channels are excavated between islands on the left. Spur dikes are added to protect the right-bank levee from impinging flows and to train the current more toward the center of the channel.

In the near future, 5 to 15 years hence, sediment is trapped and vegetation has begun to establish along the fences and root wads (Plate 23). Twenty years hence, vegetation has increased and is reinforcing the islands (Plate 24). Fifty years hence, the vegetation is fully matured and well established (Plate 25). Throughout the project life, flow capacity in the main channel as well as the secondary channels will be maintained by periodic gravel removal. Elements of the overall restoration plan are described in Section 5.2 below.

5.2 NER Plan Features

5.2.1 Piling Brush Eco-Fences

Eco-fences block, slow down, or deflect the force of the river current during high-flow periods in order to protect existing islands and vegetation and cause deposition of sediment where new vegetation may become established. Eco-fences allow the river to heal itself. Rather than the costly and disruptive process of placing fine sediments with heavy equipment, the river will be allowed to do the work through a natural process. See Plates 16 through 19 for general eco fence locations.

Eco-fences will be placed at the upstream end and along the sides of existing wooded islands to prevent or inhibit further soil and vegetation loss. These fences will also be placed in areas where soil and vegetation have already been lost to facilitate deposition and vegetation regrowth (Plate 30). As vegetation becomes established, it will further slow flow velocities and encourage accelerated sedimentation. Indirect aquatic habitat benefits will be gained as vegetation is reestablished (Plate 31). As the amount of vegetation increases (Plate 32), shade and material (such as leaves and insects that fall into the river, providing nutrients to river organisms) will also increase while ensuring future availability of large woody debris in to the river.

Two different types of fences: piling eco-fences and rock eco-fences, may be used. Piles will be driven and have interconnecting cables attached. Rock eco-fences, constructed of riprap, will require excavation to key the structure into the cobble, gravel, and sand substrate. Excavated material will be scooped and transported off site for upland disposal. Riprap will be trucked to the site and dumped directly into the excavations. Riprap used to construct the rock eco-fences will be large, angular rock, free of fine sediment.

5.2.2 Secondary Channels

Secondary channels, also referred to as side channels, are typically smaller channels, which parallel the main river channel (see Plate 27). Secondary channels vary in size and depth and may carry flows year-round or only during periods of high water. These channels help disperse flows and suspended sediments throughout the floodplain; they provide valuable aquatic habitat.

Secondary channels will be constructed in selected locations to improve flows to existing off-channel pools or provide flows to newly constructed pools. See Section 5.2.5 for discussion of off-channel pools. Some secondary channels exist within the leveed sections of the river. However, because of accelerated flows, these existing channels are degraded or plugged. Gravel and cobble will be excavated to either enhance existing secondary channels or to construct new channels.

Because of the remote locations and potential disturbances to wetland and riparian vegetation by trucks accessing the excavation sites, dredged cobble, gravel, and sand will either be scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. The determination of whether to side-cast material or transport it from the site will be based upon the potential impacts of ingress and egress of trucks to the site. If dump truck access routes having minimal disturbance upon vegetation are available, the material will be scooped and transported to a permitted gravel processing facility for disposal. Excavated gravel and cobble may be screened, depending upon the proximity of the site to the gravel screening area and anticipated need for +4 inch cobbles to rearmor excavation sites. Side-cast material will be uniformly spread on adjacent unvegetated gravel deposits below the ordinary high-water mark in the dry and above the low flow of the river. Fine sediments such as silts and sands will be placed in locations to promote riparian habitat restoration.

5.2.3 Gravel Removal

Gravel removal will be used to varying degrees in the implementation of the various environmental restoration tools to provide more channel stability and provide sediment deposition in controlled areas. Principally gravel removal will be used to improve fish habitat, compensate for reductions in channel capacity, increase channel stability, and improve sediment transport. Gravel removal will be used to construct channel stabilization pools, secondary channels, and off-channel pools. It will also be removed from specific areas of the channel to compensate for the decreases in channel capacity. All gravel removal will be accomplished using a track-mounted excavator, rubber-tired backhoe, or other similar equipment along with trucks to transport the material to disposal and stockpile sites.

Areas (from which gravel is removed to maintain channel capacity and to construct channel stabilization pools and off-channel pools) will be rearmored on the bottom surface using cobbles

screened from the excavated material. Gravels, which are removed, will be either transported to a site located between the levees for screening or will be transported as unscreened material to an existing gravel processing facility off site. Screening will separate out cobbles +4 inch in diameter or larger for use as armoring material. It may be necessary to temporarily stockpile the screened material.

The -4 inch material will be transported from the screening location by truck for off-site upland disposal prior to anticipated high flows. The +4 inch cobble will be transported by dump truck from the screening site to the channel capacity, side pool, and channel stabilization pool excavation sites and placed to rearmor the disturbed bed. The material will be dumped in wind-row fashion, perpendicular to the normal stream flow to allow subsequent high flows to naturally disperse the material. The +4 inch cobble will be placed prior to anticipated high flows.

5.2.4 Channel Capacity Excavations

Channel capacity excavation will be used to offset reductions resulting from construction of the environmental restoration tools and effects of the tools upon channel structure and function. Additionally, channel capacity excavation will compensate for ongoing channel aggradation and loss of channel capacity. Channel capacity will be reduced by the installation of anchored root wad logs; discharge of riprap to construct rock eco-fences, spur dikes, and rock grade control; and from the deposition of bedload material and resultant regeneration of vegetation. Bedload deposition will be intentionally triggered by structures such as the eco-fences and anchored root wad logs. Channel capacity excavations will be necessary to compensate for the effects of the environmental restoration project and maintain the 100-year base flow for flood protection (see Plate 26).

5.2.5 Channel Stabilization Pools

Channel stabilization pools reduce flow velocity, catch bedload material, and reduce the transport of bedload material to downstream areas, which may already have an over abundance of material. These functions improve channel stability and may improve fish habitat through the creation of a large pool. Channel stabilization pools will be excavated in strategically selected locations to trigger the deposition of bedload material and sediments.

5.2.6 Off-Channel Pools

Off-channel pools provide important rearing habitat for cutthroat trout. Access to potential spawning areas in spring creeks and secondary channels and pools has been severely reduced by construction of the levees. This lack of adequate spawning habitat is considered a major limiting factor for cutthroat trout in the Snake River.

Off-channel pools will be constructed within the alignment of the secondary channels to provide rearing habitat for cutthroat trout (Plate 28). Some existing pools will be used and may only require limited excavation to enhance their function. Other pools will require complete excavation. Excavated cobble, gravel, and sand will be either scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. Depending upon the proximity of the site to the gravel screening area and anticipated need for +4 inch cobbles, the excavated gravel may be screened. Side-cast material will be uniformly spread. Side-casting will occur below the ordinary high-water mark in the dry, and above the low flow of the river.

The determination of whether to side-cast material or transport it from the site will be based upon the potential impacts of ingress and egress of trucks to the site and the opportunity to enhance riparian habitat as described above. If dump truck access routes that have a minimal disturbance on vegetation are available, the material will be scooped and transported to a permitted gravel processing facility for disposal.

5.2.7 Spur Dikes

Spur dikes will provide areas of resting habitat close to areas of high velocity, which may transport high quantities of aquatic insects used as food by cutthroat trout and other species and provide protection against bank erosion. Spur dikes will be installed in areas where stream velocity is normally too high for fish to spend much time. These resting areas may be further enhanced with the incorporation of large woody debris on the downstream side. The large woody debris will be placed in areas of ineffective flow.

Spur dikes consist of a series of either kickers or bank barbs extending into the channel from the adjoining levee (Plate 29). Riprap used to construct the spur dikes will consist of large angular rock, free of fines. It is likely that spur dike construction will require in-water work. Both

kickers and bank barbs will be composed of riprap armor. Kickers may extend as much as 60 feet from the levee. Random fill excavated to embed the kickers will be used as the core material. Equipment used to excavate for the kickers and to place riprap will sit atop the levee and will maneuver onto the top of kickers, when necessary. Bank barbs, which are smaller than kickers, will extend up to 30 feet into the channel from the levee. Both types of structures will be embedded into the levee.

5.2.8 Anchored Root Wad Logs

Anchored root wad logs consist of tree trunks with the root attached. Depending on placement, anchored root wad logs may provide additional resting habitat for cutthroat trout and other fish species. The 1989 Jackson Hole Debris Clearance Environmental Assessment found that "local scour and fill is also evident adjacent to woody debris left in the channel following the 1986 flood." Anchored woody debris may also encourage sediment deposition and help establish new vegetation (Plate 33).

Anchored root wad logs will be obtained from along the river channel within the four project areas or from commercial sources. Logs will be transported to the installation site by truck, rubber-tired skidder, or helicopter. A backhoe may be used to level an area to place the logs so that the logs would have uniform bearing along the trunk and its root would be partially embedded. The logs will be fastened down with toggle bolt anchors. The anchors will be driven into the ground with a jackhammer and a jack will be used to pull up on the anchors locking them into place. The cable will be tied around the logs and cinched down to tighten the logs to the ground.

5.2.9 Rock Grade Control

Rock grade control structures keep the river from eroding and destroying existing riparian areas. Riprap will be placed at specific areas where down-cutting of the channel threatens channel stability. Existing cobble, gravel, and sand will be removed to a standard uniform depth of 3 feet below the ground surface. The material will be scooped and transported off site for upland disposal. This area will then be graded and refilled with riprap to match existing topography. Riprap will be transported to the site by truck, dumped, and spread using the anchor track-

mounted excavator. Riprap used to construct the rock grade control will be large angular rock, free of fine sediments.

5.3 Monitoring and Maintenance

Monitoring will be conducted during construction to ensure compliance with various requirements identified in Appendix H, Environmental Assessment, which contains its own Appendix A, Biological Assessment (BA) and Appendix B, Fish and Wildlife Coordination Act Report (CAR). Monitoring will also be conducted following completion of construction to assess changes to aquatic and terrestrial habitat; to identify effects of river flows on the structures, as well as effects of the structures on the river; and to identify the need for structure maintenance. Monitoring procedures for structure integrity and function and for aquatic and terrestrial habitat changes have been identified in a Monitoring Plan.

5.3.1 Monitoring Plan

The purpose of the Monitoring Plan is to assess the effectiveness of the restoration features on aquatic and terrestrial resources. The plan will serve to ensure compliance during construction and assess functional performance of the restoration tools and effects on aquatic and terrestrial habitat. Monitoring will also include the implementation of any project modifications, repairs, or added features that may be necessary for any unforeseen circumstances that may impair project performance, and may include the fine-tuning of project operation to improve overall effectiveness during the effective period of the Monitoring Plan. An annual report summarizing observed damage, required repairs, and observed physical and environmental resource changes associated with the various restoration features will be prepared.

The Monitoring Plan will be in effect for 5 years following the completion of construction at each site. The plan is provided in full as Appendix F to the Environmental Assessment (Appendix H to this study). The cost associated with the monitoring program will be included as part of the construction cost estimate for the project, and will be shared with the local sponsor in accordance with the cost-sharing requirements specified for project implementation. The Monitoring Plan has an estimated total cost of $1,691,000 for the full 5-year program. Results obtained through monitoring will enable the Corps of Engineers and local sponsor, through coordination with local

agencies, regulatory authorities, landowners, and other interests, to make informed decisions concerning management of the project to obtain planned performance. The Monitoring Plan will also build an information base to support future restoration decisions regarding the design and performance of the restoration measures.

5.3.2 Project Maintenance

At the end of the monitoring period, and upon receipt of the O&M manual, the local sponsor will assume normal OMRR&R responsibility for the project, which may include longer-term monitoring to be conducted as part of the local sponsor's O&M responsibilities. Such future requirements will be funded entirely by the local sponsor.

During the first few years of use, an elevated level of maintenance is expected until the system stabilizes and information is gathered that may identify more efficient uses of structures. Certain structures are likely to require maintenance to ensure they continue to function as designed. The shifting nature of the braided river is expected to have some effect upon the structures; however, the extent of effects will vary between structures and from site to site depending upon river conditions. Some structures may require only minor maintenance while others might require more substantial reconstruction. The frequency with which maintenance may be necessary and the extent of necessary repairs will be dictated by the frequency and extent of river effects upon the structures. Maintenance will likely be necessary to maintain and ensure the proper function of eco-fences, secondary channels, channel stabilization pools, spur dikes, and off-channel pools. Maintenance is not expected to be necessary on the remaining environmental restoration tools; however, monitoring will be necessary to assess the need for maintenance.

It is unlikely that vegetative growth from the environmental restoration project will adversely impact flood control. The channel typically has adequate room to adjust its location and conveyance. This is particularly true if the channel alignment is stabilized and excessive erosion is reduced. The designated mid-channel pool areas will provide a means of maintaining adequate conveyance by removing excessive gravel before it has an opportunity to build up in the channel. However, it will be important to assure that "maintenance" does not involve activities that progressively increase the cross-sectional area of protected vegetation at any point along the channel beyond that indicated in the original design drawings.

Maintenance of environmental restoration tools will be conducted in accordance with the limitations and restrictions of the EA (Appendix H) and its appendixes. The local sponsor may be responsible for acquiring some state or local permits necessary to implement maintenance.

5.3.2.1 Eco-Fences

Maintenance measures for the eco-fences should provide for minimal adjustment of fence lengths or alignment, repair of damaged cables or piling, and reestablishment of the fence tie-off to the bankline if erosion damage threatens to destroy the function of the fence, increase bank erosion, or threaten adjacent flood control structures. This could involve removal of some portions of fence if it proved to be poorly aligned or improperly located.

Maintenance will most likely be necessitated by failed posts and fencing or by erosion around the landward end of the fence. Repairs will involve reestablishment of the fence tie-off by extending the fence back to the undisturbed bankline, repositioning existing piles and cable, installing longer posts, reattaching the cables, or adding other material to trap debris. In some cases, it might be sufficient to drive and attach additional supporting posts in locations where the fence is beginning to sag or fail. Work will be done during low flows.

Depending upon how the river affects the fence site, maintenance work may or may not occur in the water. If a fence is failing to catch debris, trapping efficiency might be increased by adding a finer mesh screen that will capture smaller debris, or exposed areas may be covered by dragging some of the debris over to places where it is deficient. If debris is failing to be trapped or is being deflected around the fence, it may be necessary to add one or more fence panels oriented upstream near the end of each fence. In some areas, adjustments in the location or angle of eco-fences may be needed if the river abandons the channel.

5.3.2.2 Secondary Channels

The deposit of gravel and subsequent blockage of the upper end of the channel would necessitate maintenance. If groundwater is inadequate, the secondary channels will need to be reopened to provide an adequate inflow of water for the downstream pools. Gravel blockages will be

excavated sufficiently to provide 2 to 3 (cfs) flow. Excavated gravel will be side-cast due to the anticipated small quantity.

5.3.2.3 Channel Stabilization Pools

The quantity of sediment being transported downstream cannot be precisely calculated and is expected to vary from year to year. Because of this, the optimum size of channel stabilization pools, and their anticipated effectiveness, is not known. Removal of gravel from channel stabilization pools (*i.e.*, sediment traps) as part of O&M will generally occur when one-half or more of the original gravel volume of the pool is refilled. Only about 50 percent of the original pool area will need to be disturbed to remove the quantity necessary to maintain the trap. Excavation will not vary from or exceed the original design. The pools will have to be closely monitored to ensure excessive excavation does not occur. Under average conditions, several years may be necessary to fill a channel stabilization pool; however, it is possible that a single flood event could fill one completely. Experience over time will determine the appropriate level of maintenance.

5.3.2.4 Off-Channel Pools

Off-channel pools will be subject to refilling during high-flow seasons. Pools that are close to the main channel could be refilled with gravel and cobbles in a single high-flow season. Those farther away will likely last a number of years, refilling with silt and sand brought in by the interconnecting channels and by general overbank flow during high-flow periods. Due to the braided nature of the river, it is nearly impossible to select locations where pools would always be protected from potential destruction by major flood flows or channel changes. Based on this, various approaches to maintaining off-channel pools will be used.

Pools near the margins of the active meander belt will be allowed to fill completely. A new pool will then be constructed nearby, without disturbing the old pool or its water supply. Where possible, the new pools will be built either upstream or downstream of the existing pools in order to use the same supply channels. Pools constructed near the main channel in the vegetation-free areas of the channel will be reexcavated only when completely filled with gravel. These channels could be filled in completely during a major event, which could also involve major changes in the main channel. The main channel may even cut a course through the center of a

pool. In the latter case, the pool will be reexcavated at another location (probably along the previously abandoned channel). The objective will be to approximately maintain the same area of pools throughout the life of the environmental restoration project either by re-excavation at the same location or relocation of a pool to a more advantageous site. Maintenance will be performed during the low-flow period.

5.3.2.5 Spur Dikes

Spur dikes will occasionally be damaged by high flows. Measurements, taken at various locations on the existing channel, indicate that erosion can extend down to at least 15 feet below the high-water level. The mode of damage most likely to occur will be undercutting of the toe of the dike and collapse of material into the void with material being transported downstream. Maintenance of bank barbs or kickers will generally involve reestablishment of the toe and restoration to the original geometric outline. Maintenance could include placement of additional bank or toe protection, strategic placement of boulders or intermediate barbs to break up the undesirable flow pattern if undesirable flow patterns are created. In a worst-case scenario, the spur dike group can be removed. It is anticipated that a staged construction sequence will allow design adjustments to be made as experience is gained from the performance of these structures.

5.4 Real Estate

The real estate needs described below are for the initially proposed NER Plan and thus reference Areas 1, 4, 9, and 10. Real estate requirements for the Progressive Plan will occur during the PED phase for each specific additional site. Real estate requirements, such as coordination, easements, and assignments will be conducted with property owners and the BLM. No new requirements are anticipated beyond those addressed in Appendix F, Real Estate or in this section of the Study (Section 5.4). Unforeseen requirements will be carried out by the non-Federal sponsor in coordination with the Corps. This proposed environmental restoration project will occur upon privately owned lands and lands administered by the BLM. Lands will be altered through the removal of gravel and placement of materials to construct the environmental restoration tools. These alterations, however, would not eliminate any current land uses identified above or introduce any new land uses. The local sponsor will obtain real estate

instruments, which the sponsor identifies in their real estate report as being necessary for implementation of environmental restoration work on Federal and private lands.

5.4.1 Ownership Data

Property ownership and estimated individual tract requirements within each of the project areas are shown in Appendix F, Real Estate, and summarized below. In some instances there are multiple parcels located within the proposed sites that are under single ownership. In those cases, each parcel will be treated individually with site-specific easement language.

Area 1	Encompasses an area of approximately 360 acres. Given the current location of the thread of the active river along the west edge of the floodplain, four ownerships are recognized as being affected by the proposed project. Two private ownerships and one public ownership (BLM) are located within the site, and one private ownership will be affected by access to the site.
Area 4	Includes approximately 157 acres within nine riparian ownership's ranging from 4 to 32 acres. Six of the parcels are from 13 to 32 acres, the other four are smaller.
Area 9	Includes approximately 89 acres within 1 riparian ownership's ranging from 0.5 to 70 acres. Seven of the parcels are from 0.5 to 1.5 acres. One BLM tract is 70 acres.
Area 10	Includes about 335 acres within 13 ownership's ranging from 1 to 65 acres per tract with 8 parcels 10 to 65 acres and 7 ranging from 1 to 9 acres each.
Areas A-H	Real Estate requirement to be conducted during the PED phase prior to construction.

5.4.2 Real Estate Requirements

Real estate requirements are based upon site maps with restoration features located given the existing geomorphology as of the year the aerial photos were taken and do not necessarily represent the actual projects.

a. Existing Easements. To the maximum extent possible, the Federal Government and the non-Federal sponsor will use existing easements to implement the restoration project. However, in most cases the physical boundary limitations of the existing flood control easements do not completely encompass the areas required for the proposed project, therefore additional easements will be required.

b. Additional Easement. Where restoration features are proposed for a parcel where an easement does not exist or is insufficient, an appropriate easement for ecosystem restoration will be procured by the sponsor on a willing-seller basis. The easement will be for the purpose of restoring the Snake River's natural environment, and will be crafted to acquire only the rights needed for the particular restoration features to be located on that particular parcel.

For parcels on which access rights do not exist or are insufficient, the non-Federal sponsor will acquire a road easement estate if required for permanent access. For temporary access, rights will be acquired under a temporary work area easement or temporary road easement.

c. Special Requirements. The BLM is the land manager on three parcels within the initially proposed NER Plan restoration areas. The BLM does not currently have a land management plan in place for the land along the Snake River. Application for a free use permit will be required if bedload material is to be excavated. For planning purposes, it is estimated that ecosystem restoration easements will need to be acquired on approximately 34 parcels from 37 landowners. For Areas 1, 4, 9 and 10, the BLM will require free use permits on 3 parcels. Additional easements for sites A-H are anticipated to have similar requirements.

Teton County is the land manager in one of the proposed restoration areas and has regulatory authority over gravel extractions. Upon initiation of the project, a comprehensive extraction permit would be sought from the County to cover all of the proposed extractions within the project scope. Plans providing the excavation details will be delivered to the Teton County Planning Office and held for review by the planning staff.

The Wyoming Department of Transportation has a maintenance easement at the Jackson-Wilson Bridge which lies within one of the proposed restoration areas. While no permits are required, an excavation plan which involves this area should be sent to the Resident Engineer for review.

d. Real Estate Requirements by Area. The following section summarizes areas and parcels within Areas 1, 4, 9 and 10, the existing easements, and what easements will be needed.

Table 5.1 - NER Plan Real Estate, Area 1

Note: Access to both sides of the project will be from the levee systems on both sides of the river. Appropriate notice will be given to landowners along the levees prior to any construction.

Landowner	Restoration Features	Landowner	Restoration Features
Joyce Lucas/Bob Lucas	Channel capacity Excavation Side pool excavation Brush fences Anchored logs or trees Supply channels for side	Bureau of Land Management	Sediment trap
Sewell Partners	Brush fences Anchored logs or trees	Porter Estates	Access to area

Table 5.2 - NER Plan Real Estate, Area 4

Note: Access to both sides of the project will be from the levee systems on both sides of the river. Appropriate notice will be given to landowners along the levees prior to any construction.

Landowner	Restoration Features	Landowner	Restoration Features
Tozzi	Eco-fences Sediment trap	Circle L Partners	Eco-fences Supply channel Anchored logs or trees Channel capacity excavation
Cheramy	Eco-fences Sediment trap	Ford-North	Sediment trap
Malinski "A"	Sediment trap Supply channel	Neilson Ranch-North	Spur dike Sediment trap Pool
Malinski "C"	Eco-fences Sediment trap Supply channel Side pool Anchored logs or trees	Ford-South	Sediment trap Pool Supply channel Anchored logs or trees Eco-fences
Canyon Oaks	Eco-fences Sediment trap Supply channel Side pool Anchored logs or trees Channel capacity excavation	Neilson Ranch-South	Eco-fences Supply channel Anchored logs or trees Channel capacity excavation Pool
Lammers	Eco-fences Supply channel Anchored logs or trees Channel capacity excavation	Roliz	Eco-fences Supply channel Anchored logs or trees Channel capacity excavation Pool

Table 5.3 - NER Plan Real Estate, Area 9

Note: Access to both sides of the project will be from the levee systems on both sides of the river. Appropriate notice will be given to landowners along the levees prior to any construction.

Landowner	Restoration Features	Landowner	Restoration Features
Bureau of Land Management	Eco-fences Anchored logs or trees Rock grade control Channel capacity excavation Pool supply channels Anchored logs or trees	Jacobson	Channel capacity excavation
River Springs Partners	Channel capacity excavation Spur dikes	Thieme	Channel capacity excavation
Wyoming Department of Transportation	Channel capacity excavation	Rino	Channel capacity excavation
Kindred	Channel capacity excavation	T.S.R. Limited	Channel capacity excavation Anchored logs or trees
Zachritz	Channel capacity excavation	Bresden	Pool Anchored logs or trees Channel capacity excavation
Teton County	Channel capacity excavation		

Table 5.4 - NER Plan Real Estate, Area 10

Note: Access would be covered under existing easements unless reconfiguration of the channel network requires access from the northwest corner of the project area.

Landowner	Restoration Features	Landowner	Restoration Features
Core Partners	Sediment trap Spur dike	W.G.V.B.	Sediment trap Anchored logs or trees Channel capacity excavation
Hoke	Anchored logs or trees	Berney	Anchored logs or trees
John Dodge Homeowners (#51)	Eco-fences Anchored logs or trees	Bear Island Partners	Anchored logs or trees
Cohen	Pool	Ackerman	Spur dike Eco-fences Anchored logs or trees Sediment trap
Mead	Spur dikes Sediment trap	Bird	Eco-fences Sediment trap
Cook	Sediment trap Pool Eco-fences Anchored logs or trees	Wolfensohn	Sediment trap
Bureau of Land Management	Pool Anchored logs or trees Eco-fences		

5.4.3 Summary of Real Estate Costs

The sponsor will use a non-standard channel improvement easement for ecosystem restoration, where a levee easement does not already exist or is insufficient, to obtain access and the right to install restoration features. (The sponsor will not use condemnation to obtain any easement or access). The restoration features proposed will likely benefit the properties involved. Therefore, compensation normally awarded to offset any adverse effect of a proposed activity usually requiring an easement (*i.e.*, utilities), is insignificant in this case.

Real estate costs for Areas 1, 4, 9, and 10 are summarized in Table 5.5 below. Detailed cost breakdowns are provided in Appendix F, Real Estate. For planning purposes it is estimated that easement acquisition will occur at a nominal cost of $1,000 per easement for not more than 34 parcels. All costs are in 1999 dollars. Real estate costs for Areas A-H are expected to be similar and are included in the Progressive Plan cost estimates.

Table 5.5 - NER Plan Real Estate Costs

Study Area	Land	Administration (Sponsor)	Administration (Government)	Total
Area 1 (Phase D)	$2,400	$12,000	$3,600	$18,000
Area 4 (Phase C)	14,400	71,200	14,400	100,000
Area 9 (Phase B)	9,600	47,600	10,800	68,000
Area 10 (Phase A)	14,400	71,000	15,600	101,000
Total initially proposed NER Plan Real Estate Costs (Areas 1, 4, 9, and 10)				$287,000
Total Progressive NER Plan Real Estate Costs (Areas A-H)				793,000
Grand Total Progressive NER Plan Real Estate Costs (Areas 1, 4, 9, 10 and A-H)				$1,081,000

5.5 Transportation

Impacts upon transportation would occur as a result of construction of the environmental restoration project and subsequent performance of work to maintain the structures. Both construction and maintenance will require similar measures to implement. However, maintenance will likely involve less effort than actual construction; therefore, potential impacts from maintenance should be less than those of construction activities.

The transport of construction materials and supplies to the project areas will increase truck traffic on primary highway routes and secondary roads. Trip repetitions for this type of traffic will generally be limited; therefore, any impact upon traffic patterns from this particular truck activity is expected to be minimal.

The ingress and egress of gravel trucks between gravel screening sites and upland disposal areas at existing gravel processing facilities will likely generate the greatest traffic increase on primary and secondary roads. Because the quantity of gravel that may be transported will reasonably vary from site to site and from year to year, establishment of an estimate for the number of repetitions necessary to perform construction and maintenance is difficult. It is reasonable to expect peaks in truck traffic that will add to or create traffic congestion.

Conflicts may exist between contractors performing maintenance of the Jackson Hole Flood Control Project and contractors constructing the environmental restoration project. The Corps will address such conflicts that occur on the Jackson Hole Flood Control Project access roads and levees. The local sponsor will identify any transportation conflicts on public roads and implement traffic control measures (such as flaggers or signage) at locations that experience more than minimal increases in traffic congestion. Operation of loaded trucks on the Jackson Hole Flood Control Project levees and access roads during construction and maintenance will likely cause impacts to the surface of these structures. The Corps will ensure repair of such surface impacts resulting from construction. The local sponsor will be responsible for repairs to the surface resulting from their post-construction maintenance activities. Because surface repairs will be implemented, impacts upon the access roads and levees would be temporary.

Staging areas for fuel and lubricant storage and dispensing will be located outside of the leveed sections of the Snake River. Staging outside the levees will dramatically decrease the potential

for unintentional releases of toxic materials into the Snake River. A minimum of one staging area will be necessary at each of the three working areas. Staging areas will be selected and any easements, licenses, or permits necessary for staging areas will be acquired by the local sponsor. The contractor and any subcontractors will be required to submit for approval, prior to initiation of construction, a hazardous materials spill and cleanup plan including tools and materials that will be on hand and readily available to facilitate containment and cleanup. All overnight equipment storage, as well as refueling and maintenance activities, will be restricted to staging areas. Based upon the above measures, no more than minimal, short-term impacts upon transportation are expected from either maintenance or construction of the environmental restoration project.

Access to work areas will occur primarily upon the roadways identified below, in addition to other unnamed roadways. Access will generally originate from public roadways and may use roadways already under easement for access to the levees for the purpose of performing O&M activities. Real estate instruments necessary for access will be identified in the local sponsor's real estate report. The local sponsor will coordinate acquisition of necessary real estate instruments.

The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river will be necessary. The contractor will coordinate with the Corps' biologist, a representative for the flood control project, and the landowner (in the field) to determine the optimum access routes for minimizing disturbances. The east and west access points for Areas 1, 4, 9 and 10 is described below. Access to areas A through H will be determined in the PED phase.

5.5.1 Area 1 Access

The west portion of Area 1 will be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to Sewell Levee, continuing along Sewell Levee to the work area. The access to the upstream work area originates from Fall Creek Road and follows a dirt road to the work area. This access will need to be determined in the field.

The east portion of Area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment will follow the levee until it terminates. After the levee ends, access will continue through existing shrubs and trees and over gravel bars. The contractor will coordinate with the Corps in the field to determine the optimum routes for minimizing disturbances.

5.5.2 Area 4 Access

The east portion of Area 4 will be accessed from the Federal Levee Extension. Construction equipment will leave the public highway, approximately 4 miles to the north and follow the left bank of the Federal Levee Extension to the work area. Access to the west portion of Area 4 will be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates at the channel bottom. The contractor may need to navigate across gravel bars and around existing vegetation.

5.5.3 Area 9 Access

Access to the east portion of Area 9 will be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, an access point to the specific work areas will be selected in the field. Access for the west portion of Area 9 will originate from State Highway 390. From State Highway 390, the contractors will follow an existing dirt road to the Right Bank Federal Levee.

5.5.4 Area 10 Access

The work on the east portion of Area 10 will be reached from the downstream direction or the upstream direction. From the downstream direction, equipment will travel from State Highway 22 and then up the Left Bank Federal Levee for approximately 3 miles to the work areas. From the upstream direction, equipment will travel from Cattleman's Bridge, which is approximately 2 miles away, to the Hanson Levee. The spur dikes located to the north will be accessed from Spring Gulch Road, which is about 2 miles away. Most of the work in Area 10 lies to the west of the river and will be accessed via the Right Bank Federal Levee. From the levee, construction equipment will traverse existing gravel bars and around or through vegetated areas to the specific

work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee will be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

5.6 Socioeconomics

The NER Plan is expected to yield the most benefit to the riparian and aquatic habitat. When the Progressive Plan alternatives are implemented the Corps speculates that over the 50-year project period it will help maintain the average annual fish numbers (cutthroat trout and other species) at their present population. Without the environmental restoration project, aquatic and riparian habitat will be expected to decline over the next 50 years. The environmental restoration project, by improving the aquatic and riparian habitat, is also expected to enhance the aesthetics of the area to visiting sports persons and tourists, in general, regardless of their objectives in visiting the Jackson Hole area. By increasing the amount of vegetation in some areas, people may have a better experience when they go fishing. Most fishermen probably would rather see trees and other vegetation than bare cobble and gravel.

Based on statistics furnished by Jackson Hole Economic Development Council Web site, local jobs maintained by the $143,000,000 output related to sports fishing, accounts for about 25 percent of the total employment of Teton County. If this output and associated sales are maintained, 4,500 jobs will be enhanced in the area.

5.7 Recreation

The Snake River in the vicinity of the NER project principally experiences recreational use from rafting and fishing, with some waterfowl hunting. Existing levees are used for a variety of recreational purposes including walking, hiking, jogging, bicycling, cross-country skiing, horseback riding, bird watching, nature viewing, picnicking, and other similar uses. The levees also provide access for direct river use such as fishing and waterfowl hunting. The NER Plan has the potential for both short-term and long-term impacts upon recreational uses. Recreational use could potentially be affected by construction, impacts from the presence of completed structures, and impacts from structure maintenance.

The effects of construction activity will occur principally in the form of short-term impacts. These impacts will occur during ingress and egress of equipment to the work sites and during actual on-site construction. Access to the work sites will occur over a variety of routes and for a variety of purposes. Access will be necessary to transport equipment, materials, and supplies to and from the work sites. Some routes will require use of levees and others will not. Of the levees that will be used for ingress and egress, some receive recreational use and others do not. Those that receive recreational use have the potential for user conflicts to develop.

At Area 9, the public has access to both the Right and Left Bank Federal Levees. Since these are proposed for construction access, a short-term impact is expected. In addition, access to reach the Left Bank Federal Levee on the east side will be through an existing conservation park used by recreationists, and access to the Right Bank Federal Levee will occur upon an existing unpaved road leading to a boat launch and parking area

The majority of recreation use in the project areas occurs near the Highway 22 Bridge in Areas D, 9, E, and 10, which witnesses year-round activity. Levees at Area D, 9, E, and 10 will be used in support of construction and will be clearly signed at all access points to alert users to the presence of trucks and other equipment. Because the greatest use by recreationists occurs on the Left and Right Bank Federal Levees upstream of the Jackson-Wilson Bridge at Areas D, 9, E, and 10, the greatest inconvenience upon recreationists will likely occur at these locations. A flagger would be posted, when necessary, at the Area 9 boat ramp to coordinate use between recreationists and construction equipment using the site for ingress and egress to construction areas.

Operation of equipment upon levees accessible to the public will create a conflict for persons hiking or walking the levee. As indicated above, traffic control measures, such as flaggers or signage, will be used at locations that will experience more than minimal conflicts between recreationists and construction-related activity. Such situations will be identified and resolution measures implemented by the local sponsor. Impacts from construction-related activity upon levee users will be temporary and will be minimized through the use of measures referenced above.

Gravel removal to maintain channel capacity and construct channel stabilization pools will occur in areas of the primary river channel. In-channel work may also involve construction of temporary water diversions or berms to reroute flows and de-water gravel removal sites. Spur

dikes will be constructed adjacent to levees where the high-velocity flows of the primary channel occur. Rafters and float fishermen will be the primary recreationists likely to be affected by the in-channel work. Fishermen fishing from the bank or wading will be less affected. The primary effect upon rafters and float fishermen will occur from the temporary alteration of the primary channel flow. The proposed gravel removal will have only a minor effect upon rafters and float fishermen.

Presence of completed eco-fences, channel stabilization pools, anchored root wad logs, and spur dikes will change the configuration of the river channel and effect flow patterns. Eco-fences, anchored root wad logs, and spur dikes will result in more permanent changes to the channel than will the channel stabilization pools. Channel stabilization pools will trap bedload materials, therefore becoming less prominent over time. However, maintenance of the channel stabilization pools after they have filled with bedload material would result in renewed changes in configuration and flows.

Permanent changes in the channel are expected to have long-term, yet minimal impacts upon rafters and float fishermen. Rafters will have to become accustomed to the new configuration and flows resulting from spur dikes, anchored root wad logs, and eco-fences. Because these structures will not be in the middle of the primary flow, rafters and float fishermen should have little difficulty negotiating or bypassing the structures. The effort required for rafters and float fishermen to learn the new changes are expected to be no greater than is required each year after seasonal high flows. The permanent changes in configuration and flow will not de-water the channel or restrict access. The permanent changes have considerable potential to provide long-term benefits to recreational users through the creation of additional fish habitat.

If structures are damaged by high flows, parts of structures, such as cables from eco-fences, could pose a hazard to rafters and float fishermen. To alert river users to the presence of the new structures, the local sponsor will implement a public information campaign and perform monitoring and maintenance to identify potentially unsafe structure conditions.

Gravel removal to maintain channel capacity and construct channel stabilization pools is expected to have even less impact on recreationists than the eco-fences, channel stabilization pools, anchored root wad logs, and spur dikes. Channel stabilization pools will cause slower flows, creating a pool effect, therefore not posing a hazard or barrier to floaters. This change is not expected to have more than a minimal effect on rafters and float fishermen. Floaters and rafters will likely experience improved floating conditions due to stabilization of the channel.

Overall, the permanent, long-term effects upon recreation resulting from the presence of the completed structures are expected to be minor.

The effects of maintenance upon recreation activities will be similar to those resulting from construction. However, work required to perform maintenance is reasonably expected to be less than would be required to actually construct the environmental restoration project. Primary effects will result from ingress and egress of equipment and actual construction activity and will be short-term.

A public information campaign will be implemented by the local sponsor to inform the recreating public about the environmental restoration project and possible conflicts between recreationists and construction activities. The campaign will include installation of appropriate signage at all levee access points and at the ramp and conservation park at Area 9. An information brochure will be prepared and distributed by the local sponsor to all fishing and rafting outfitters as well as placed at information boards at public access areas. Other sources available to the local sponsor for distributing information to the public may include the print media and radio. The campaign will be implemented both prior to and during construction.

5.8 Aesthetics

The Jackson Hole area is popular as a year-around recreation destination. The area's spectacular scenery is of national significance, as evidenced by the establishment of the Grand Teton National Park in 1929. The proposed environmental restoration project areas are located in the outwash plain of the Snake River. The river channel is relatively wide and braided with extensive areas of gravel bars. Riparian vegetation is found along many of the channels. Stands of trees, composed primarily of cottonwoods, willow, and alder are scattered throughout the outwash plain. Views of the floodplain, by boaters and other recreationists using the Snake River, are generally restricted because of adjacent riverbanks, levees, and vegetation. The primary views along the rivers are of the mountains, particularly the Grand Teton Mountains, which can be viewed beyond the riverbanks and levees in locations where there are openings in the riparian vegetation.

Since the mid-1990's, Area 1 has undergone extensive lateral erosion due to the "firehose" effect of concentrated river flows emerging from the confined channel upstream. The installation of

eco-fences and anchored root wads will help to reestablish island vegetation as well as help to reestablish island vegetation as well as help protect existing islands and encourage growth of new islands.

The vegetation at Area 4 is predominately shrub-willow. Most of the existing islands currently within the channel are devoid of vegetation due to island instability and changing river flows. The installation of eco-fences and anchored root wad logs will help reestablish island vegetation.

The river at Area 9 is somewhat restricted and the islands are devoid of vegetation. The vegetation along the shoreline is predominantly shrub-willow. Rock grade control structures will be constructed flush with the existing channel bottom and will help prevent bank erosion and degradation of existing habitat. Eco-fences and anchored root wad logs will assist in revegetation of existing islands and establishment of new islands. Spur dikes will be used to provide bank protection and enhance fisheries habitat by creating flow diversity and enhancing pools, fish resting areas and riffles, thus improving the visual quality of the riverbanks.

Area 10 is located at the confluence of the Gros Ventre and Snake Rivers. This area has extensive cottonwood vegetation on existing islands and along the shoreline. Eco-fences and anchored root wad logs will assist in promoting a more diverse vegetative cover along existing shorelines and encourage the growth of new islands. Spur dikes will enhance fish habitat and provide additional bank protection. This will allow regeneration of native plants as well as improve the visual quality of the riverbanks.

The removal of gravel to maintain channel capacity and construct channel stabilization pools and the presence of the anchored root wad logs, eco-fences, off-channel pools, and secondary channels are not expected to contrast sharply with the existing surroundings. The proposed measures are expected to create long-term potential for restoring aquatic and terrestrial habitat along the environmental restoration project area. Over time, with the reestablishment of islands and vegetation, the aesthetics of the project area would improve.

During construction stockpiled gravel, screened cobble, and discharged riprap for eco-fences, spur dikes, and rock grade control will contrast with the surroundings however, stockpiling of gravel and screened cobble may not occur. If it does, visual impacts would be temporary because the material will only be in place a short period of time. Accumulation of woody debris on the piling and rock eco-fences will cause their visual contrast to be short-term. Rock grade

control will be unobtrusive due to the embeddedness of the material. Contrast of the spur dikes to existing surroundings will be evident to rafters and float fishermen traveling the river and to persons visiting areas that are publicly accessible. Anchored root wad logs will blend in with the setting.

5.9 Cultural Resources

A copy of the Corps' Survey Report was forwarded to the Wyoming Division of Cultural Resources, State Historic Preservation Office, for review and concurrence. In their letter of February 12, 1997, the SHPO responded that no sites meeting the criteria of eligibility for the National Register of Historic Places will be affected by the environmental restoration project. The SHPO recommended the project proceed in accordance with state and Federal laws, subject to the following stipulation: "If any cultural materials are discovered during construction, work in the area should halt immediately and the Corps and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken." Refer to Appendix H, Environmental Assessment, which contains Appendix D for the SHPO letter concurring with the Corps' determination of "no effect" for areas 1, 4, 9 and 10. Additional coordination may be needed for areas A-H which will be conducted during the PED phase.

5.10 Cumulative Effects

The Flood Control Act of 1950 authorized flood protection by levees and revetment along the Snake River in the Jackson Hole, Wyoming area. The project was completed in the fall of 1964. Levees have been added to the system by other agencies and by emergency flood fight operations of the Corps and Teton County through 1997. The effect of these measures has been the alteration of the physical character of the river, both inside and outside of the levees, along approximately 25 miles between Moose Bridge and South Park National Elk Feedgrounds. Presently, the following effects have been observed:

- The width of the Snake River floodplain is reduced by the levees.
- Flow velocities through the leveed sections are increased.
- Elevated quantities of bedload material is transported through the area.

- Islands and associated vegetation is eroding.
- Water flows to spring creeks outside of the levees have been reduced.
- Spawning habitat for cutthroat trout has been reduced or destroyed.
- The composition and quality of riparian vegetation outside of the levees is changing.

The environmental restoration measures being proposed under the Jackson Hole, Wyoming, Environmental Restoration Project, will have both short- and long-term effects on the Snake River.

Environmental restoration measures proposed for Area 1 include excavation of a single channel stabilization pool and four off-channel pools with connecting upstream and downstream secondary channels, construction of eco-fences, and placement of anchored root wad logs. Construction will result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures will have long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat.

Environmental restoration measures in Area 4 will include: excavation of two channel stabilization pools and three off-channel pools with connecting upstream and downstream secondary channels; construction of eco-fences and spur dikes; placement of anchored root wad logs; and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction will result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. The completed structures will cause long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat by stabilizing the channel and allowing recovery of aquatic and terrestrial habitat. Actions proposed in Area 4 will not add to the cumulative adverse effects caused by previous flood control actions at Area 4.

Environmental restoration measures in Area 9 will include: construction of eco-fences, spur dikes, placement of anchored root wad logs, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction will result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures in Area 9 will result in long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat. The changes attributable to the collective effect of actions proposed for Area 9 will

decrease nonbeneficial effects of past flood control activities and cause an overall net increase in beneficial effects in the long-term. No measurable increases in the net detrimental effects caused by previous flood control activities will occur.

Environmental restoration measures in Area 10 will involve excavation of a single channel stabilization pool and two off-channel pools with connecting upstream and downstream secondary channels, construction of eco-fences, placement of anchored root wad logs, spur dikes, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction in Area 10 will also cause minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Water quality, recreation and aquatic and terrestrial habitat will benefit in the long-term from the presence of the completed structures. Changes caused by the cumulative effect of actions proposed for Area 10 will cause the nonbeneficial effects from past flood control activities to diminish. In the long-term, an overall net beneficial increase in aquatic and terrestrial habitat will occur.

Environmental restoration measures in Areas A through H will have similar effects as those anticipated for Areas 1, 4, 9, and 10. The cumulative effect for restoration of the entire 22-mile reach of the Snake River from Teton National Park to the South Park Elk Feedgrounds is significantly greater than result of restoring one or more of the individual areas identified in this Study.

The cumulative effect of past and proposed actions along the Snake River will not cause additional reduction in the width of the floodplain, increase flow velocities through the levied areas, increase transport of bedload material, destabilize the channel, erode islands and vegetation between the levees, or diminished flows to spring creeks outside of the levees. The cumulative effect of the proposed environmental restoration project will be improved water quality through reduced velocities and stabilization of the channel, reduced erosion of islands and loss of vegetation, opportunity for the reestablishment of islands and vegetation, and creation of additional habitat for cutthroat trout and other aquatic and terrestrial species.

5.11 Project Performance

The paragraphs below describe the expected performance and effectiveness of each project element within the restoration areas, and the impacts to areas downstream of the proposed projects.

5.11.1 Eco - Fence

Fence structures of various designs have been tested for use as bank protection or river training structures. A number of these designs and case histories are described in the December 1981 U.S. Army Corps of Engineers Publication, *Final Report to Congress: The Streambank Erosion Control Evaluation and Demonstration Act of 1974, Section 32, PL 93-251.* In some cases, particularly in meandering streams where the flow velocities were low, they have proved effective in collecting sediment and stabilizing the channel. The effectiveness of fences in braided channels with high-velocity flow is much less certain.

The effectiveness of the fences will depend, to a large degree, on the amount of floating debris available in the river and actually trapped against the fences. In order to be effective, the fences must trap enough debris to uniformly block most of the flow along the length of the fence. If too little accumulates, the current may pass through the fence with little or no velocity attenuation. An upstream fence may trap most of the available debris, reducing the supply to downstream fences. Depending on the angle of attack, floating debris may be deflected and fail to become trapped against the fences. There is also a risk that excessive flow may escape under floating debris, or erode a path under the fence below the lowest cross-cables.

Failure of some fence projects in other locations has resulted from insufficient depth of supporting posts, breakage, or an alignment that allowed the flow to bypass or flow behind the fence. At impingement points, velocities of 12 fps (or even higher) have been measured during peak flows. The end of the fence extending out into the channel will be exposed to the greatest stress. There will be erosion around the toe, force fluctuations resulting from debris striking the fence or shifting position, and vibration caused by vortex shedding. In the most severe case, erosion may extend to a depth of up to 15 feet below the water surface. Debris may not collect effectively at the end of the fence leaving the fence exposed at this location. Since undercutting

is likely to be the worst at the end of the fence, experience may dictate the need to extend cross-cables and wire mesh to a greater depth at this location.

The need for a minimal level of maintenance cannot be overemphasized. The visual impact of the fences could become a major consideration. The fences will create a scalloped pattern of vegetation and debris, with the tips of the fences forming the points. Insufficient debris may leave the tip of the fence or other portions of the structure exposed. With no maintenance, a failed fence could become an eyesore and a possible hazard with partially-buried woody debris mixed with a tangle of steel posts and cables strung out downstream of the original construction site.

The number and extent of river training structures is not sufficient to assure that the river cannot escape and follow an undesirable alignment. The river will change course frequently and may, for a time, completely abandon the spur dikes, fences, and other restoration features.

5.11.2 Secondary Channels

It should be assumed that most of the small secondary channels leading to off-channel pools will be blocked by gravel at their upper ends after each runoff season. Although groundwater seepage will provide some flow, it should be assumed that most of channels will have to be re-opened each season in order to provide an optimum exchange of water for the downstream pools. Starting at the edge of the main channel, a small connecting channel will be extended downstream or the existing channel will be deepened until a flow of 2 to 3 cfs was developed in the channel leading to the pool.

In some areas sufficient flow may be developed from groundwater seepage without actually having to connect the channel to the main river. The channel-excavation would typically be around 4 feet wide at the bottom, 200 feet long, and 3 feet deep. A backhoe would typically be used to excavate the channels. Where possible, particularly in vegetated areas, it will be desirable to remove the excavated gravel. However, in may cases the amount of material will be small or the location inaccessible, and less disturbance will be involved if material were side-cast and graded to blend with the surrounding terrain.

The secondary, supply channels will have little effect on the overall hydraulics of the system. Hydraulically, these channels will be successful if they survive through successive high-flow periods without excessive maintenance. However, the channels will not be useful if the substrate and flow-regime does not contribute to improved habitat.

5.11.3 Channel Stabilization Pools

Since the supply of sediment being transported downstream is not precisely known and may vary by at least an order of magnitude between years, the optimum size and effectiveness of the sediment traps is not known. Gravel removal will need to be closely controlled and its effects monitored. Removal of more gravel than is being re-supplied will result in progressive lowering of the channel bed within the designated sediment trap boundaries, excessive headcutting upstream, and excessive channel entrenchment downstream. This could lead to a local depression of the water table, and undercutting of the toe of the riprap on nearby levees.

During the coldest winter months of November-February, the potential for ice blockage of the active, low-flow channel will be increased in vicinity of the gravel trapping areas. The low-flow channel may be frozen clear across at times with part of the flow passing under the ice cover and the remaining flow backing up and overflowing into secondary channels that would normally be dry at this time of the year. Since the distance between the levees is several times the width of the low-flow channel, and there is no development immediately adjacent to the low-flow channel in other areas, this condition is not expected to create any increased risk of flooding or other serious problems.

5.11.4 Off-Channel Pools

Depending on the location and the timing of high flows, pools could be refilled with gravel and cobbles and totally eliminated before they have existed long enough to perform a useful role. In the worst case, some of the pools may be eliminated by the next high flow after construction. Pools in most areas will be subject to refilling during high-flow seasons. If this process occurs over a period of time it can actually be beneficial, since it will provide a controlled sequence of differing plant communities and provide more diverse habitat. In some locations the pools may serve a dual role as habitat providers and sediment traps. Those located some distance from the

main channel will likely last a number of years. They will gradually refill with silt and sand brought in by the interconnecting channels, and by general overbank flow during high-flow periods. Due to the braided nature of the river, it is nearly impossible to select locations where pools will be subjected to a predictable level of protection from flood events. An additional potential problem is isolation of the pool and entrapment of fish during low-flow periods due to excessive seepage into the gravel bed or banks of the pool. Freezing of the pools and secondary channels during the winter may also be a consideration.

5.11.5 Spur Dikes

Spur dikes will occasionally be damaged by high flows. Measurements at various locations on the existing channel indicate that erosion can extend down to at least 15 feet below the high-water level. It would not be practical to construct the dikes with large enough stone and with a deep enough toe to avoid any possibility of damage. The mode of damage will likely be undercutting of the toe of the dike and collapse of material into the void with some material being transported downstream. Repair will involve adding enough riprap to restore the original geometry.

5.11.6 Effects of Alternatives on Existing Hydraulic Conditions

At Area 1, the NER Plan includes channel excavation, eco-fences, sediment traps, spur dikes, side pools, anchored woody debris, supply channels, and a modest shortening of the channel. No rises in the 100-year water surface are expected as a result of the restoration measures. The model shows lower water-surface elevations up to about 1 ft in the excavated areas. Localized rises upstream of the channel restoration work are results of extrapolation inaccuracies. Fence structures are to be located in previously vegetated areas. The gravel removal and channel shortening should shift the river regime slightly toward channel entrenchment, increasing channel stability and reducing the risk of flooding and erosion.

At Area 4, the NER Plan includes channel excavation, eco-fences, sediment traps, spur dikes, side pools, anchored woody debris, and supply channels. As documented in Appendix B, Hydrology, the 100-year water-surface elevations are lowered as a result of the project (Plate 34). Average channel velocities for all events (10-, 50-, 100-, and 500-year and 1997 historical

flood) are generally higher in the restored condition and reflect increased efficiency due to the channelization components.

At Area 9, the NER Plan includes channel excavation, eco-fences, side pools, staggered log protection, anchored woody debris, spur dikes, grade control, and supply channels. The 100-year water with-project surface elevations are generally less than or equal to the existing water-surface elevations throughout the restoration area (Plate 35). (Note: The rise in water-surface elevation shown at cross section 13 on Plate 35 is due to a mathematical anomaly in the profile and not to any physical change in the river.) The with-project average channel velocities are considerably lower in the downstream portion of the area, but are equal to or higher than the existing velocities in the upper section.

At Area 10, the NER Plan includes channel excavation, eco-fences, sediment traps, side pools, spur dikes, anchored woody debris, and supply channels. The 100-year water with-project surface elevations are generally lower in the downstream portion of restoration area, but are somewhat higher (on the order of 1 foot) in the upstream portion (Plate 36). However throughout the entire site, the with-project profile is lower than the 1973 Flood Insurance Study profile. The with-project average channel velocities were somewhat lower (but almost equal) in the downstream portion of the area but were generally higher in the upstream portion.

Area A through H effects will be determined during the PED phase. The features will be designed to the same standards as Areas 1, 4, 9, and 10. The project flood profile will be lower than the 1973 *Flood Insurance Study* profile.

5.11.7 Downstream Impacts

Downstream impacts from the proposed restoration projects are minimal. In terms of flood control, the proposed changes to the low-flow channels and installation of sediment traps only affect the project area and do not affect downstream water-surface elevations or velocities (see Tables 7 through 9 and 11 through 13 in Appendix B, Hydrology). In terms of levee maintenance, the restoration alternatives will tend to guide low flows away from the banks and levees and toward the center of the river, and will reduce impingement on the levees and the associated erosion in the immediate downstream vicinity of the project. However, given high bedload of the system and the random nature of the low-flow channel morphology between the

levees, the river training effects of the restoration measures will not carry forward downstream of the project areas for any appreciable distance.

The development of all areas identified in the Progressive Plan will have a stabilizing effect on the entire reach from Teton National Park to the South Park Elk Feedgrounds. The Progressive Plan is expected to provide restoration to important natural resources and reduce flood control maintenance requirements.

5.12 Coordination with other Regional Restoration Initiatives

The focus of this project will extend beyond its physical improvements. The community, local interest groups, and property owners have indicated their support for this project and their desire to create additional restoration opportunities. Currently local interests are considering a Section 1135 project to restore flows behind or landward of the levees for restoration of spawning habitats. The intent of the flood control project modification study (Section 1135) will be to restore spring creek and wetland values. The Teton County Conservation District, along with the WGFD, Trout Unlimited and the National Fish and Wildlife Foundation, are expending additional efforts in restoring riparian and spring creek habitats behind the levees. This study and the resulting construction will further stimulate local, regional, and natural restoration interests. The overall goal of the supporting interests of this project is to create a long-term cultural shift toward the natural management of these important sustainable resources.

6. PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the environmental restoration features of the proposed NER Plan.

6.1 NER Plan

The identified NER Plan provides the maximum National Ecosystem Restoration (NER) benefits. Because of its positive contributions to improving the environmental values within the Jackson Hole study area, Alternative A3+B3+C3+D3 (50-year piling eco-fence designs and other features as described in Section 5 at Areas 1, 4, 9, 10 and A through H) is recommended for implementation.

6.2 Division of Responsibilities for Implementing Recommended Plan

The WRDA 86 and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource projects accomplished under direction of the Corps. Anticipated Federal and non-Federal responsibilities are described in this section. The final division of specific responsibilities will be formalized in the project cooperation agreement.

6.2.1 Federal Responsibilities

The estimated Federal share of the total first cost of the project is 65 percent of first costs (first costs are all costs to implement project less LERRD and O&M costs). The Federal government responsibilities are anticipated to be:

a. Design and prepare detailed plans and specifications.

b. Administer contracts for construction and supervision of the project after authorization, funding, and receipt of non-Federal assurances.

c. Conduct all necessary cultural resource investigations and coordinate and implement any necessary preservation or mitigation measures.

d. Conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements

6.2.2 Non-Federal Responsibilities

Non-Federal or local responsibilities are anticipated to be:

a. Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below:

1. Enter into an agreement, which provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs;
2. Provide, during construction, any additional funds needed to cover the non-Federal share of design costs.
3. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;
4. Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and
5. Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

c. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land, which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

e. Comply with Section 221 of the Flood Control Act of 1970 (PL 91-611), as amended, and Section 103 of the WRDA 86, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

f. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterment's, except for damages due to the fault or negligence of the Government or the Government's contractors.

g. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

h. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

i. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

j. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

k. Prevent future encroachments on project lands, easements, and rights-of-way, which might interfere with the proper functioning of the project.

l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (PL 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

m. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964 (PL 88-352), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army.

n. Provide 35 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration.

o. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

6.3 Preconstruction Engineering and Design Phase

The PED phase will follow the feasibility study. The purpose of this phase is to complete all of the detailed, technical studies and design needed to begin construction of the Jackson Hole Environmental Restoration Project. This phase ends with the completion of the first detailed construction drawings and specifications (often called plans and specs, or P&S).

Preconstruction engineering and design will be cost shared between the Corps and the sponsor in the same proportions as the project's construction cost (65 percent Federal and 35 percent non-Federal). The major documents prepared during this phase will be the design memorandum (DM), which will include the results of advanced technical engineering studies and design; the plans and specifications, which are the detailed drawings and instructions for building the project; and the project cooperation agreement (PCA), which describes the sponsor and Corps responsibilities for project construction, operation and maintenance.

Key events during the PED phase will include:

- Begin the PED phase when the Walla Walla District receives funds.
- Update Real Estate Plan (REP).
- Design memorandum approved (DM).
- Plans and specifications approved (P&S).
- Project cooperation agreement (PCA) prepared.

6.4 Construction Phase

The construction phase will begin after Congress appropriates funds specifically for the initiation of construction of the Jackson Hole, Wyoming, Environmental Restoration Project and these funds are allotted to the Walla Walla District. The project cooperation agreement will then be signed after Congress appropriates funds for construction. Formal notification for the sponsor to proceed with real estate acquisitions will occur after the PCA is signed.

Construction work at the project site will begin soon after the PCA is approved and executed, the real estate easements are acquired, and a construction contract is awarded.

Two major documents are also prepared during this phase: the construction contract, which is the agreement between the Corps and the contractor(s) about how the project will be built, and the project operation and maintenance (O&M) manual, which specifies the instructions for the sponsor to follow for project use after construction is finished. In addition, National Environmental Policy Review for Areas A through H will occur.

Key events during the construction phase will include:

- Appropriation of construction funds.
- PCA approval and execution.
- Construction contract advertised.
- Construction contract awarded.
- Phased construction of restoration features initiated.
- Approval of operation and maintenance manual.
- Completion of construction.
- Acceptance of project and transfer to sponsor.

6.5 Construction Phasing

The twelve recommended restoration areas constitute the entire project, and from a construction standpoint, can be considered as independent projects. If all 12 of the areas are implemented, construction will require 15 years for completion. The first area will require six years to complete, followed by the second area, requiring 5 years, the third area 4 years, and all remaining areas 3 years. Construction can be initiated at one or more site each year. Each area will be monitored for physical and environmental performance for a period of 5 years following completion of construction for the affected area. It is recommended that work begin on Area 9 first, and then proceed through Areas 1, 4, 10, and A through H. Socioeconomic and

environmental factors, as well as changes in the river channel, may modify the priorities and require a change in the order of construction.

Rock barbs and off-channel pools may be constructed at any time during the construction year, if groundwater conditions and environmental requirements are met. However, channel capacity excavation and eco-fences must perform as a completed unit during the high-flow period. In order to maintain adequate conveyance, priority will be placed on completion of the channel excavation. In no event will the eco-fences be completed prior to completion of the excavation in an adjacent channel. Channel excavation, replacement of oversize material, removal of stockpiled gravel from the active channel area and construction of eco-fences will be completed prior to the beginning of the spring runoff period. Most construction is likely to occur during the low-flow period and during moderate weather. Gravel extraction will be more difficult, fence piling will be hard to drive, and soil cannot be effectively replaced and compacted at the fence tie-off points when the ground is frozen.

6.6 Project Monitoring Phase

A post-construction assessment Monitoring Plan was developed to address three general aspects of the project: compliance, validation, and effectiveness. Monitoring will address the project objectives and determine project effectiveness. Adjustments ("fine-tuning") to the project (and operations) may be undertaken in the field to correct any deficiencies that are limiting factors for ecosystem restoration benefits. The monitoring program will be no longer than 5 years following the construction of the project at each site. The cost associated with this activity will be cost-shared with the local sponsor in accordance with the cost-sharing requirements specified for project implementation and is included in the project construction costs. The total cost of the 5-year program is estimated at $1,691,000 at October 1999 price levels.

6.7 Operation and Maintenance Phase

Following completion of the monitoring period at each site, all responsibility for ongoing project operation and maintenance including repair, rehabilitation, and major replacement will be turned over to the sponsor. The sponsor's responsibilities in this phase also include final certification of all necessary real estate and permit requirements for completion of project O&M. Detailed

O&M requirements will be specified in the project O&M manual to be developed during the PED and Construction Phases of the project. All O&M requirements in this phase are funded 100 percent by the sponsor. O&M activities for the project include maintenance of eco-fences, secondary channels, channel stabilization pools, and spur dikes. Anticipated O&M requirements are discussed in Sections 5.3.2 Project Maintenance, and 5.11 Project Performance.

6.8 O&M Efficiencies for Flood Control Projects from Environmental Project

The removal of gravel to create and stabilize channels and the construction of spur dikes and eco-fences is expected to reduce the cost of maintaining the existing flood protection project. This will be accomplished by directing flows away from levees and stabilizing the river within certain limitations, which will reduce impinging flows. Impinging flows are channel shifts that direct the flows directly against levees. When this occurs, the velocity of the flow often exceeds 12 feet per second, and may remove the protective layer of rip rap from the levee. Removing the rip rap from the levee face exposes the gravel cobble core to rapid erosion and failure.

By stabilizing channel movement throughout the restoration project impinging flows are less likely to occur. One of the tools used in environmental restoration are spur dikes. Spur dikes, as discussed in this report, extend perpendicularly or at a slight up or down angle (depending upon the specific design) deflecting the flow and reducing the energy impacting the levee. Spur dikes will be constructed in the environmental restoration project to create and enhance fisheries habitats. A secondary benefit of spur dikes is reduced levee maintenance. During the maintenance of the environmental restoration project, spur dikes requiring repair will be inspected in the field by the Corps Chief, Emergency Management Branch and the sponsor, Teton County. When it is determined that a damaged spur dike will provide levee protection, the cost of the repair will be credited to the flood control maintenance project. It is envisioned that the final location of the spur dikes will be a joint effort of the Corps, Emergency Management Branch and Teton County. Spur dikes will be located in high-energy locations where they provide levee maintenance benefits and fisheries habitat. Consequently, it is envisioned that spur dike repairs will be made as part of flood control project operation and maintenance.

6.9 Cost Allocation

Cost allocation is the practice of allocating the separable costs of a project to the project purpose that they serve. For this project, all costs have been allocated to the purpose of NER.

6.10 Cost Apportionment

Cost sharing for construction of this project will be in keeping within current Corps of Engineers policy whereby for environmental restoration projects, the non-Federal share will be 35 percent of the project implementation costs (pre-construction engineering and design, and construction). Non-Federal sponsors shall provide 100 percent of LERRDs, and OMRR&R. The value of LERRD shall be included in the non-Federal 35 percent share. Where LERRD exceeds the non-Federal sponsor's 35 percent share, the sponsor will be reimbursed for the value of LERRD that exceeds the 35 percent non-Federal share. After appropriate accounting for LERRD and required non-Federal sponsor project coordination activities under the terms of the Design Agreement and the Project Cooperation Agreement, any balance of the non-Federal share will be provided in cash during construction. Table 6.1 below provides a summary of the cost apportionment between the Federal and non-Federal interests for the initially proposed NER Plan.

Table 6.1 - Basic Cost Apportionment (FY99 Dollars)

BASIC PROJECT			
	FEDERAL (65%)	NON-FEDERAL (35%)	TOTAL
ECOSYSTEM RESTORATION	$33,957,300	$18,284,700	$52,242,000
LERRD'S VALUE	---	(1,081,000)	(1,081,000)
CASH CONTRIBUTION	33,957,300	17,203,700	$51,161,000

6.11 Completed, Current and Future Work Eligible for Credit

There is no completed work, current or planned future work that is eligible for credit under existing Corps policy. However, the non-Federal sponsor has completed during the course of the feasibility phase, advance restoration measures that are consistent with the recommended Federal plan, providing valuable information regarding the effectiveness and viability of the proposed project elements. The costs associated with the measures that have been implemented in advance by the local sponsor are not included as part of the overall project cost.

6.12 Institutional Requirements

Before an agreement is signed for Federal construction of the cost-shared project, the local sponsor will prepare the following financial analysis:

- The local sponsor's project-related yearly cash flows (both expenditures and receipts where cost recovery occurs), including provisions for major rehabilitation and operational contingencies and anticipated, but uncertain repair costs resulting from damages from natural events

- The local sponsor's current and projected ability to finance its share of the project cost and to carry out project implementation operation, maintenance, and repair/rehabilitation responsibilities.

- The means for raising additional non-Federal financial resources including but not limited to special assessment districts.

- The steps that the local sponsor will take to ensure it will be prepared to execute its project-related responsibilities at the time of project implementation.

In addition, as part of any Project Cost Sharing Agreement, the local sponsor will be required to undertake to save and hold harmless the Federal government against all claims related to environmental restoration, and other activities, associated with this project.

6.13 Environmental Requirements and Regulatory Permitting

The initially proposed NER Plan would result in the discharge of fill material into waters of the United states during the period of construction. It also may result in longer-term discharges associated with O&M activities. A Section 404(b)(1) evaluation was prepared to address Clean Water Act issues and a 401 Certificate was obtained from the Wyoming Department of Environmental Quality for Areas 1, 4, 9, and 10. Additional compliance will be conducted for Areas A through H during their respective PED phases. Applicable local or state permits are the requirement of the local sponsor.

In the Alternative Formulation Briefing held July 1999 in Portland Oregon, the sponsor and local interests expressed an interest in private individuals being able to use the tools developed in this study. The Corps (Walla Walla and Omaha Districts) will request funding to explore the development of regional permits under Section 404 of the Clean Water Act. Regional permit development efforts could begin in FY 00 during the Planning, Engineering, and Design phases of this project. The Corps hopes to develop criteria so that the tools developed in this study (channel creation; spur dikes; eco-fences; anchored woody debris; and secondary pools and channels) may be used by private individuals. Criteria (materials, designs, hydrologic functions, and biological functions) will be available for the individual use of these tools and for the combined use of various tools under specific physical and biological conditions. Public and agency input is considered in the development of regional permits.

6.14 Sponsorship Agreements

The local sponsor (Teton County) will provide a Letter of Intent acknowledging sponsorship requirements of the Jackson Hole, Wyoming, Environmental Restoration Project. The letter will be provided in May 2000 following the development of a memorandum of understanding with Teton County Conservation District. Prior to the start of construction, the local sponsor will be required to enter into a Project Cooperation Agreement (PCA) with the Federal Government that it will comply with Section 221 of the Flood Control Act of 1970 (PL 91-611), and the WRDA 86.

7. SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

7.1 Non-Federal Views and Preferences

The non-Federal views and preferences regarding environmental restoration measures, and the problems they addressed, in general were obtained through coordination with the local sponsor and with the other various local and regional public agencies, community activists, resource conservation groups, and the general public. These coordination efforts consisted of a series of public meetings held during the reconnaissance and feasibility phases, through surveys, through the maintenance of a point-of-contact that any interest could discuss matters with, and a mailing list by which invitations to public meetings were distributed. Announcement of public meetings was made in local newspapers, giving date, time, place, and subject matter.

7.2 Views of the Non-Federal Sponsor

The sponsors, Teton County and the Teton County Conservation District have provided a strong partnership with the Corps throughout the study. Fifty percent of the overall requirements of the study (25 percent cash and 25 percent in-kind work) were contributed by the sponsor. In-kind products such as real estate were complex tasks were performed professionally, in coordination with property owners and local interests, and internally coordinated with Corps staff. The sponsor(s) have indicated their willingness to continue support during the project's implementation phase. In October 1998, the sponsor(s), with Corps over-sight and assistance embarked on a demonstration project that is representative of some of the key elements found in the Corps' initially proposed NER Plan. The demonstration project was funded by Teton County, in cooperation with Teton Conservation District, a private contractor, and the National Fish and Wildlife Foundation. The demonstration project was completed in 1 year and is being monitored. The supplementary section at the end of this study includes a report (*Final Report: Snake River Restoration Demonstration Project*, by Teton Conservation District) and an article ("The Good Flood" from the Ingersoll-Rand technical publication, *Compressed Air)*, which describe the demonstration project. This local effort accomplished three important milestones:

- It demonstrated the sponsor's interest and ability to sponsor the restoration effort.
- It demonstrated the sponsor's ability to raise money.
- It provided a model for the public and interest groups to see, and for technical entities to analyze possible with-project performance.

7.3 Study Management and Outreach

The study team was a multi-disciplinary group that consisted of several functional elements of the Corps and the local sponsors, and included study managers, the project manager (a wetland scientist), planners, civil design engineers, hydrologists and hydraulic engineers, environmental specialists, biologists, cost estimators, real estate specialist, economists, legal advisors, and geotechnical specialists.

The Corps and sponsor(s) conducted approximately four Steering Committee meetings and several property owner meetings each year of the study. The locally driven Steering Committee coordinated the management of the reconnaissance-level study with various Federal, state and local agencies, and environmental groups. The Steering Committee was comprised of representatives of the public, Federal, and State agencies, and special interest groups. The Committee obtained public views and comments on proposals, plans of study, scoping, impacts of proposed alternatives, and draft documents. At regular meetings during the reconnaissance study, the Steering Committee informed interested parties of the project's progress to avoid misunderstandings. Local news reporters and congressional staff attended many of the meetings.

At the Reconnaissance Review Conference held March 31, 1994, eight representatives from private industry, private property owners, environmental agencies and organizations, and Teton County traveled to Portland, Oregon, to express interest in the approval of a feasibility-level study.

The local representatives, Teton County Commissioners Steve Thomas and Grant Larson, have stated clear support for the feasibility and implementation phase.

Much of the coordination efforts have focused on scoping the study to a cost level affordable to the county. Don Barney, Teton County Road and Levee Supervisor, and Rik Gay, Teton County Conservation District, have provided guidance and leadership at the local level. Mr. Michael Gierau, and most recently Bob Sherwin, Teton County Commissioners, have provided continuity

from the previous (November 1994) Commission to the present Commission. The Walla Walla District met with the Commissioners on August 14, 1995, to further define the county's concerns and financial ability, and have executed the feasibility study accordingly.

The study has received considerable media attention, which was facilitated and coordinated by the sponsor's PR person and Corps PAO. Three notable features/articles have been published in the May 1998, *New York Times* Science; an article in *Spirit Magazine, Southwest Airlines* of May 1999; and a feature from the January-February issue of Ingersoll-Rand's technical publication, *Compressed Air* (see copy in supplemental section of this report).

7.4 Alternative Formulation Briefing Review Conference

An Alternative Formulation Briefing (AFB) Review Conference was held in Portland, Oregon on July 22 and 23, 1999. The AFB served to present the methodological approaches applied in the study's various technical analyses and to ensure that the study was proceeding in compliance with Corps of Engineers planning and policy regulations. Conference attendees from the Corps of Engineers included representatives from HQUSACE, Northwestern Division, and Walla Walla District offices. Other participants in the conference included representatives of Teton County, Wyoming (study sponsor), Teton Conservation District (study sponsor), the National Fish and Wildlife Foundation, and local citizens.

The AFB was held to discuss and resolve issues identified in the review of a 75 percent draft version of the Jackson Hole Environmental Restoration Study feasibility report and technical appendices to facilitate and accelerate the completion of the final feasibility report. Major issues identified included:

- Need for certified independent technical review documentation.
- Need for additional documentation of environmental habitat studies and trends.
- Need for discussion of relationship of proposed restoration features to surrounding ecosystem.
- Need for resolution of ability to use existing flood control levee easements for restoration project.
- Need for development of a comprehensive Real Estate Report (REP).

- Need for documentation of proposed schedule for construction phasing.
- Need for a complete list of local cooperation items in the report.
- Need to address potential efficiencies related to Federal and non-Federal maintenance responsibilities for the flood control and restoration projects.
- Need to address standards for utilization of tools developed in conjunction with the restoration project in locations along the Snake River outside the four specific study areas.
- Need to address permitting requirements in association with the Omaha Regulatory office with the goal of developing conditions for a Section 404 permit(s) for the use of restoration tools employed by this project to be used in development of regional permits for use by other interests.
- Need to address adaptive management and monitoring program.

Following the AFB, each of the above review items was addressed in preparation of a final draft feasibility report, which was submitted to HQUSACE for policy compliance review, along with documentation of the Independent Technical Review and a compliance memorandum indicating how and where each of the comments were addressed in the report.

7.5 Study and Review Teams

This section summarizes the technical review accomplished during the course of the feasibility study. This review process has involved the local sponsor(s), Corps technical staff, peer review from resource agencies and other interested parties, and formal independent technical review by the study's Independent Technical Review Team comprised of members from the Corps of Engineers and the private sector. Participating agencies in development and review of the study are listed below in Table 7.1. Table 7.2 lists the individual participants on the study and review teams. 7.6 Review Milestones

Table 7.1 – Participating Agencies in Feasibility Study and Review	
Corps of Engineers (Corps)	HQUSACE
	Northwestern Division
	Walla Walla District
Teton County **Local Sponsor (LS)**	Teton County Natural Conservation District Project Steering Committee

Table 7.1 – Participating Agencies in Feasibility Study and Review (con.)	
Resource Agencies (RA)	U.S. Fish and Wildlife Service
	Wyoming Game and Fish
	U.S. Environmental Protection Agency
	U.S. Bureau of Land Management
	U.S. Bureau of Reclamation
	Wyoming Ecology Department
	U.S. National Park Service (Teton)
	U.S. National Forest Service
Other Interested Parties (OIP)	Private Property Owners (38 w/in project area)
	Trout Unlimited
	Jackson Hole Conservation Alliance
	Greater Yellowstone Coalition
Private Contractors (PC)	Tetra Tech, Inc. Infrastructure Group
	Normandeau Associates

Table 7.2 - List of Study Team and Technical Review Team Personnel

Name	Grade	Discipline	Organization	Name	Grade	Discipline	Organization
W. MacDonald	GS-12	Plan Form/Team Lead	PD	T. Davis	GS-15	Chief, Planning Division	Walla Walla District
D. Barney	Sponsor	Team Leader	SPONSOR	D. Wagner	GS-14	Planner	Walla Walla District
R. Gay	Sponsor	Team Leader	SPONSOR	K. Chesney	GS-13	Biologist	Walla Walla District
B. Tice	GS-09	Fishery Biologist	PD	M. Zook	GS-14	Real Estate	Walla Walla District
R. Tracy	GS-11	Cultural	PD	J. Daniels	GS-15	Planner	HQUSACE
R. Smith	GS-11	Env. Res. Spec.	PD	W. Bayert	GS-15	Real Estate	HQUSACE
S. Ackerman	GS-12	Wildlife Biologist	PD	M. Mckevitt	GS-14	Biologist	HQUASCE
G. Ellis	GS-12	Economist	PD	F. Einerson	GS-15	Biologist	HQUSACE
C. Sneider	GS-12	Structural Design	EN-DB-SC	T. Euston	Contract	Biologist	Normandeau
B. Williams	GS-12	Structural Design	EN-DB-SC	R. Robinson	Contract	Planner	Tetra Tech
K. Callan	GS-14	Cost Engineer	EN-CB	M. Williams	Contract	Planner	Tetra Tech
L. Cunningham	GS-12	Hydrologist	EN-H	D. Lantz	Contract	Hydrologist	Tetra Tech
D. Reese	GS-13	Hydrologist	PL-H	K. Price	Contract	Hydraulic Engineer	Tetra Tech
F. Buerstatte	GS-12	Real Estate	RE	M. Gorecki	Contract	Economist	Tetra Tech
J. Smith	GS-13	Legal-Environmental	OC	T. Weeks	GS-13	Legal-Environmental	OC
R. Carlton	GS-13	Real Estate	RE	R. Jeffrey	GS-11	Program Analyst	PM-PPM
B. Miller	GS-13	Engineer	ED-D-ME				

During the course of the Feasibility phase study, there has been on-going, independent technical review of the major report products as they have become available. Major review milestones with reviewing entity and date of review are provided in Table 7.3.

Table 7.3 - Review Milestones

Product	Review Entity	Date Completed
Project Study Plan	CORPS, LS, RA, OIP	11/96
Hydrology Report	CORPS, LS, RA, OIP	11/98
Groundwater	CORPS, LS	5/91
Engineering Report	CORPS, LS, RA, OIP	11/98
Environmental Assessment	CORPS, LS, RA, OIP	3/99
Economic Analysis (Draft)	CORPS, LS	6/99
Feasibility Report (50% Draft)	CORPS, LS	3/99
AFB Conference (75% Draft Feasibility Report)	CORPS, LS, OIP, PC	7/99
Independent Technical Review (Economics)	PC	9/99
Independent Technical Review (Engineering)	PC	9/99
Independent Technical Review (Environmental)	PC	10/99
Independent Technical Review (Real Estate Plan)	CORPS	11/99
Independent Technical Review (Cost Engineering)	CORPS	11/99
AFB Review Compliance Memorandum	CORPS	11/99
Independent Technical Review Certification	COPRS	01/00
Legal Certification	CORPS	01/00
HQUACE Policy Compliance Approval	CORPS	01/00

7.7 Independent Technical Review

Walla Walla District has completed technical review of the *Draft Feasibility Report* for the Jackson Hole Environmental Restoration Study dated December 1999. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the study's quality control plan. During the independent technical review, compliance with established planning principals and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used, the level of data obtained, and reasonableness of the results. The independent technical review was accomplished by an independent team including members from Walla Walla District and contractors from Tetra Tech Inc. and Normandeau Associates.

The primary focus areas for independent technical review of the Jackson Hole Environmental Restoration Feasibility Study were environmental studies, economic studies, hydrologic and hydraulic studies, cost engineering, and real estate. A team of qualified and experienced independent reviewers provided technical review comments for each of these categories. The review comments and all actions taken were recorded were and included in a Certification of Independent Technical Review memorandum on file with the project manger.

The nature of most comments was to ask for additional documentation or explanation of study methods and findings. Many comments were editorial in nature. None of the comments identified significant shortcomings or errors in study methods or findings. All concerns resulting from independent technical review of the draft feasibility report have been considered and addressed in the final report (and summarized in the attached Technical Review Comments forms) and then back-checked by the reviewer. In addition to the primary focus areas identified above, all associated documents required by the National Environmental Policy Act have also been fully reviewed.

7.8 Policy Compliance and Legal Review

Policy compliance and technical review issues identified at the Alternative Formulation Briefing were summarized in an Issue Resolution Memorandum following the conference. All issues were addressed in completion of the final feasibility report and were summarized in an Issue Resolution Compliance Memorandum submitted to Corps Northwestern Division and HQUSACE offices for review with the final report. The HQUSACE Policy Review branch will review the final report for consistency with all Corps of Engineers policy requirements. The final report has also been submitted to Walla Walla District Counsel for review and certification of the study's legal sufficiency.

8. FINDINGS AND CONCLUSIONS

8.1 Findings

Based upon the findings of this *Feasibility Study* for environmental restoration in Jackson Hole, Wyoming, two restoration plans are determined to be feasible. These two plans include the *initially proposed NER Plan*, and the more extensive *Progressive NER Plan* that is the result of subsequent management and sponsor review of this study, as well as coordinated partnering among regional agencies, interest groups, and the study team.

8.1.1 Initially Proposed NER Plan

The initially proposed NER Plan involves implementation at study Areas 1, 4, 9, and 10.

The initially proposed NER Plan is estimated to create a total of 104,277 aquatic habitat units (an increase of 20 percent) over the future without-project condition and a total of 11,464 riparian habitat units (an increase of 108 percent) over the future without-project condition. The proposed restoration will also improve habitat for multiple threatened and endangered species that depend on healthy and diverse river-related ecosystems. Threatened and endangered species that have been witnessed or may occur in the project area include the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf.

The initially proposed NER Plan is estimated to have a total cost of $26.23 million.

8.1.2 Progressive NER Plan

The Progressive NER Plan involves restoration of the entire 22-mile reach of the Snake River starting approximately 2 miles downstream of Moose, Wyoming, to Flat Creek at South Park National Elk Feedgrounds. This is consistent with Congressional authority to study, evaluate, and make recommendations. The Progressive Plan provides the greatest opportunity for environmental restoration of all impacted areas of the Snake River below Grand Teton National Park and above the canyon section of the river managed by the USFS.

The Progressive Plan is estimated to create a total of 398,970 aquatic habitat units (an increase of 20 percent) over the future without-project condition. The Progressive Plan will also create an estimated total of 43,862 riparian habitat units (an increase of 108 percent) over the future without-project condition. The proposed Progressive Plan will improve habitat for the threatened and endangered species (*i.e.*, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf) mentioned in the initially proposed NER Plan (see Section 7.1), but with habitats restored over the entire 22-mile reach of the Snake River. The Progressive Plan provides the opportunity for greater ecosystem influence due to the restoration of highly degraded habitat over a larger geographic area. The expanded restoration effort will provide greater synergistic effect on adjacent habitats landward of the levees.

The Progressive Plan will use a phased construction approach, implementing restoration in Areas 1, 4, 9, and 10 before Areas A through H. The Progressive Plan will enable potential local sponsors to restore sections of the river more quickly and efficiently without the cost and time required for additional feasibility studies. Advancements in ecosystem restoration will occur as a result of the Planning, Engineering, and Design phase applied to the first four study areas and lessons learned from adaptive management of those areas.

The cost per mile of restoration under the Progressive Plan varies along different parts of the river, but is within the range of costs determined for Areas 1, 4, 9, and 10. The total cost of the Progressive Plan is estimated at $52.3 million. As noted in the Draft FONSI, a factor in the elimination of the alternatives which included the additional areas suggested in the Progressive Plan was that the cost exceeded the local sponsor's current ability. The areas in the Progressive Plan will be completed based on availability of anticipated funding of the local sponsor and the COE.

8.2 Conclusions

Both the initially proposed NER Plan and the Progressive NER Plan will restore and protect important fish and wildlife habitats impacted by the Snake River Federal Flood Control Project. Both plans will provide restored habitats for multiple threatened and endangered species. Both plans will enhance diversity of animal and plant species in a geographical area in which fishing and nature-related recreation play a large part in regional and national economies. The Progressive Plan will result in optimal restoration over a more extensive portion of this

outstanding natural environment. Based upon this *Feasibility Study*, implementation of the Progressive NER Plan is recommended

This conclusion reflects the information available at this time and current Corps policies governing formulation of individual projects. The conclusion does not reflect program and budget priorities inherent in the formulation of a national Civil Works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the conclusion may be modified before implementation.

William E. Bulen, Jr.
Lieutenant Colonel, Corps of Engineers
District Engineer

Final Report

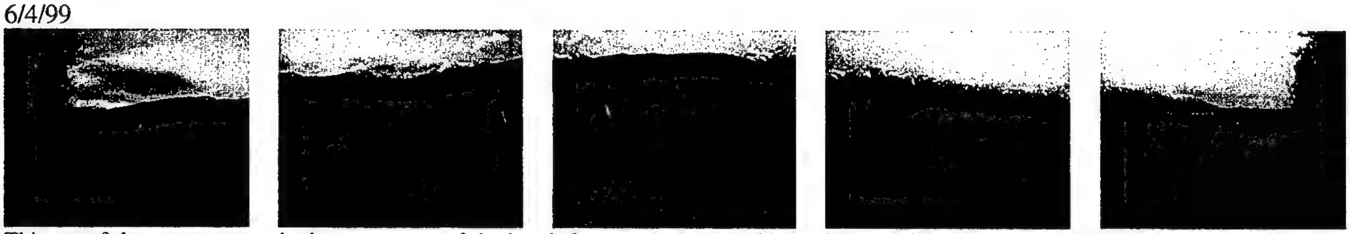
Prepared January 2000

by
Rik Gay
Executive Director, Teton Conservation District

Snake River Restoration

Demonstration Project #99-068

6/4/99

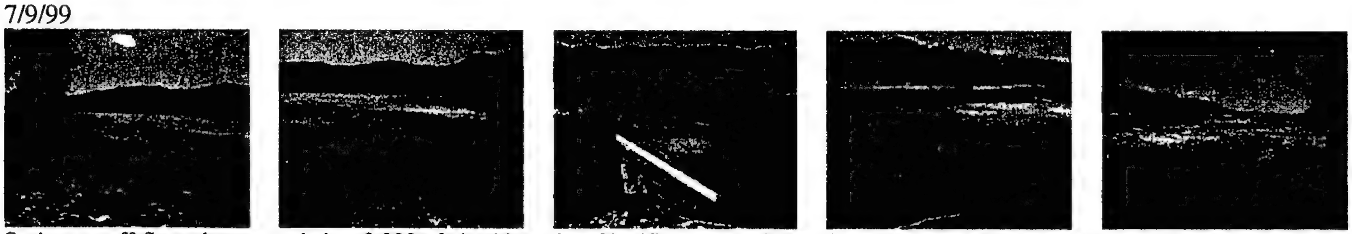


This set of three panoramas is the upper part of the brush fence area and provides evidence of how well the fences captured silt. The first series was taken at river flows of 15,900 cubic feet per second. The water had only appeared the day before in the fenced area and is "subbing" up e.g. ground water pooling at this point. Note the distance the main channel of the river is from the end of the fences. At low flow the edge of the channel was at least 40 meters from the fence in this location.

6/25/99

The second series (17,200 cfs) was taken the first day after peak runoff that the site could be accessed (20,600 at 6/18/99). The fenced area has had river flows passing through for about 15 days at this point. Note that heavy current impinging on the end of the fence at left and that the main channel of the river is trying to shift into the fenced area but is being diverted away by the fences.

7/9/99



Spring runoff flows have receded to 8,800 cfs in this series. Significant deposition of nutrient rich sediment has occurred with the fences functioning as expected. However, the fences were not designed to withstand a direct attack from such high velocities as was experienced during this event which were up to 15 feet per second in this case. Prior to runoff, the main channel of the river was well out from the fenced area. As you compare this series with that taken on June 6th you can see that the main channel has completely shifted from river right to river left. Consequently, had the fences not been in place the lower third of this island would have been attacked by the main current and would have been eroded away. To have the fences function as island protection was an unanticipated bonus.

9. SUPPLEMENT

9.1 *Final Report: Snake River Restoration Demonstration Project*, by Rik Gay, Teton Conservation District

9.2 "The Good Flood," by Jim Morrison, from *Compressed Air*, January-February, 2000 published by Ingersoll-Rand

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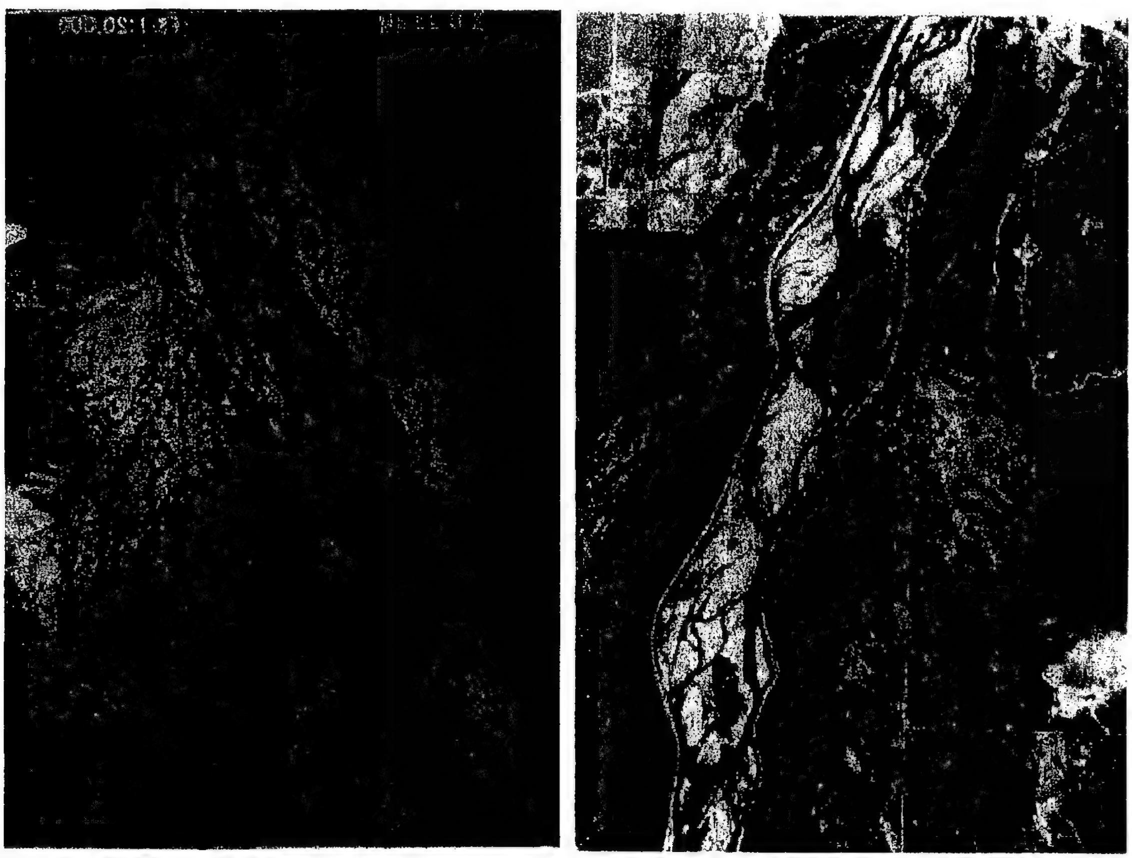
INTRODUCTION

The Teton Conservation District (formerly known as the Teton County Natural Resource District) is involved in a collaborative environmental study of the Snake River ecosystem assessing historical, existing, and potential future conditions of the riparian, riverine, and wetland habitats. The Snake River is of particular interest for several important ecological reasons. First and foremost, the Snake is one of the few remnant strongholds for a native fish population, the Finespotted Snake River Cutthroat trout. The ecosystem also provides habitat for a great number of bird species including many different varieties of waterfowl, Bald and Golden eagle populations, Osprey, and Trumpeter swans. It also supplies important habitat for elk, moose, deer, Grizzly and Black bear.

With the increased velocities created by the constriction of the Snake River floodplain within the Federal levee system, the islands and exposed stream banks within the system have become unstable. That instability has created a loss of valuable riverine, riparian, wetland, and associated habitats, including fisheries. The net loss of these desirable habitats within the leveed reach has been estimated at approximately 80-90% since 1956.



The aerial photos above illustrate the impact the levees have had on riverine habitat. The mirror images are of the same area on the Snake River just below the Wilson bridge. The photo on the right was taken in 1955 pre-levee and the one on the left in 1978 post-levee.

Aggradation of bedload material as indicated here was occurring in a number of areas along the leveed reach. Most notably in the Gros Ventre / Snake River confluence, at the Snake River Bridge, and at the lower end of the leveed reach.

It has been established through sediment range surveys first completed in 1954 that there are several sites along Snake River's levee reach that have experienced excessive aggradation of bedload material. This aggradation causes severe channel instability and diminished flood capacity in these areas.

While a significant amount of river restoration work is taking place in many different watersheds throughout the country, to the best of our knowledge no restoration work has been attempted in a high energy braided mountain riverine system similar to the Snake river in Western Wyoming. With an average slope of 12 - 14 feet per mile and the composition of the riverbed being mainly glacial outwash or cobbles, any application of "typical" restoration measures, while considered, are not applicable to this system. Therefore any of the proposed restoration actions developed during the study of this system over the last several years is considered experimental in nature and untried. Thus the need for the "Demonstration" project.

The foundation of the demonstration project was to "field test" scaled down versions of the restoration "tools" that are being proposed in the larger Snake River Restoration Project. Both current and historical conditions in the Demonstration site have been documented through cross section survey and aerial photography providing a good basis for determining the effectiveness of the restoration tools. Using cross sections and photography taken in the Demonstration project site, the locations of several historical channels were identified. The desired condition in the area was to have two main channels running full during runoff periods to disperse runoff energy in as wide an area as possible. The channels would be defined by point bars and small islands with emergent vegetation during low flow periods.

It was also desirable to have one small low flow channel separated from the main channels by a large island with multi-story 25 – 50 year vegetative growth. This side channel would provide both spawning areas and overwintering habitat for trout. To achieve this, three sites along the low flow channel were chosen to have large pools excavated in or near the side channel. Additionally, to arrest the erosion of the main island, which provided protection for the low flow channel and ponds, it was proposed to install debris fences on the main channel side of the island. It was hoped that these fences would mimic the natural process of capturing debris and

sediments, allowing for natural vegetative growth to occur. At the same time the fences would provide the protection necessary for the vegetation to mature to the point where it could stabilize the newly formed stream bank.

This report will provide details of the project and the first year's results.

THE CONSERVATION PARTNERSHIP

The Teton Conservation District (TCD) is a legally organized Conservation District by Wyoming State Statues 11-16-101 through 11-16-134 as a legal subdivision of the State of Wyoming. As a nonprofit organization operating under locally elected District Supervisors, TCD's purpose is to develop and implement programs to protect and conserve soil, water, prime and unique farmland, rangeland, woodland, wildlife, energy and other renewable natural resources. Districts also stabilize local economies and resolve conflicts in land use. The District Supervisors address local needs through a responsible conservation ethic and are supported by the State of Wyoming. TCD has coordinated and cooperated on numerous resource oriented projects. In the past TCD has relied on federal and state partnerships but is very interested in developing long-term partnerships with non-governmental organizations to enhance the stability of our organizations future operations. This project provides not only the opportunity to benefit the resource by addressing the increasing population and development pressure, but also to showcase a conservation partnership. That partnership involves agriculture, local government, the Corps of Engineers, State and Federal wildlife resource organizations and agencies, as well as non-governmental organizations in a high profile setting that receives millions of tourists annually and receives national media attention.

The National Fish and Wildlife Foundation, through it's reputation for dedication to the conservation and management of fish, wildlife, plant resources, and the habitats on which they depend, was approached as both a short and long term partner in the current Snake River restoration effort. Interim results of the current study indicate that mitigation and rehabilitation of the varied natural habitats associated with the river can be achieved. As local sponsors, both Teton County and the Conservation District have forged a successful partnership with the U.S. Army Corps of Engineers. That partnership has been extended to local agricultural interests, whom still own a majority of the land along the river, to work together toward solutions serving conservation objectives.

The Wyoming Game & Fish Department provided important guidance in the development of the side channel habitat as well as important fisheries and water quality data for the area. Additionally, special recognition as a conservation partner needs to be given to David Owen. Without his generous contribution of equipment and time for gravel removal, screening, and replacement of oversize material, this project would not have been possible. His contribution was estimated at over $200,000.

THE RESTORATION STUDY

As co-sponsor, the Teton Conservation District is an integral part of the interagency Snake River Restoration Study. This study addresses the dynamics of the Snake River including hydrology, geology, geomorphology and the concerns over the loss of wetlands and valuable habitats along the River. The four year study began in 1996 and looked at methods of improving wetland areas, reducing the loss of riverine habitats, and conservation of existing fish habitat and the improvement of historical fisheries. This Study will ultimately lead to an ecosystem based river rehabilitation program. The overall study area runs along the leveed section (approximately 24 miles) of the Snake River from the southern boarder of Grand Teton National Park to the southern end of Jackson Hole. An objective of the study was to identify restoration methods that would not "force" the river to stabilize through direct intervention but rather to encourage stability and natural revegetation through minimally invasive measures.

In the Snake River, flow velocities in both main and secondary channels tend to be high, attributable to the general steep slope of the valley. Due to the high transport of bedload the channel complex is constantly changing. During high flows, avulsion of the main channel into side channels is a common occurrence. When flows erode gravel bars, the main channel can become clogged with debris and shift direction suddenly and unpredictably. However, the construction of the federal and non-federal levees blocked the lateral spread of the river and reduced the width of the floodplain and the degree of complexity of the braided system. This limited the ability of the channel to migrate and restricted avulsion activity to the area between the levees. This concentrates the flow in the main channel of the river during runoff thereby increasing the frequency of erosive attacks upon the islands and vegetation between the levees. These artificially high energy flows and subsequent erosion prevents the natural recovery of the islands and vegetation within the river system. Bedload material brought into suspension by turbulent flow are now more likely to be carried through the system rather than be carried laterally into the slower secondary channels where the material could be redeposited over a wider area of the floodplain.

Upon review of the preliminary data during the study, including historic cross sections and aerial photography, a number of promising restoration concepts were developed. These "tools" such as planned channel excavation, pool creation, debris fences, and kicker dikes were designed to restore and protect stream bank riparian habitat in the Snake River. They had the potential to stabilize historic river channel configurations, restore flood flow carrying capacity, improve pool/riffle ratios, and enhance fish habitat while decreasing flow impingement pressure on levees. To test the experimental nature of the designs, the Demonstration Project was created to demonstrate the effectiveness of the restoration "tools" on a reduced scale prior to the completion of the overall study. Therefore if any modification were necessary then changes could be made before implementing the restoration plan in it's entirety.

THE DEMONSTRATION PROJECT

The Demonstration Project, which provided an opportunity to test proposed rehabilitation methods and contributed new information, was completed in the Fall/Winter of 1998 in the area of the Wilson Bridge on the Snake River. The Demonstration Project had three main objectives. The first objective being stabilization and restoration of streambank and riparian habitats along the Snake River by encouraging the natural island rebuilding processes (successional processes). Upstream of the Wilson bridge it was proposed to restore an existing island to pre-1986 surface area, an increase of approximately two acres. This was accomplished through by the use of pile driven "brush fences". The fences snag and trap woody debris during peak spring flows thereby reducing water velocity, causing silts and sediments to be deposited. Newly deposited sediments create a favorable environment for "volunteer" wetland and scrub-shrub vegetation. The wetland/scrub-shrub plant community will trap additional sediments which will in turn promote riparian cottonwood growth and stabilize streambank.

A secondary objective is stabilization of the river channel and restoration of the flood capacity in the area of the Wilson Bridge. This was accomplished through planned extraction of riverbed material to encourage enhanced channel stability and restore the carrying capacity of the levee reach in the Wilson bridge area[1]. An estimated 54,000 cubic yards of bedload material was to be removed from an aggraded area immediately adjacent to, and extending up the west bank upstream of, the Wilson bridge. The bedload material was to be transported to the existing gravel processing site adjacent to the proposed restoration area and processed for the purpose of separating all material ≥4" in diameter. This oversize material was returned to the excavated channel to aid in the natural "armoring" of the river channel. The final objective was to improve fisheries habitat through the removal of bedload material in an historic low flow river channel to create a series of pools and riffles. An estimated 16,000 cubic yards of additional bedload material was to be removed to accommodate the creation of pools for fish habitat.

TCD was responsible for obtaining the required permits, including writing an Environmental Assessment for the Wyoming Bureau of Land Management who has jurisdiction over a portion of the project area, project oversight and administration. The Natural Resources Conservation Service (NRCS) assisted with the field survey. The USACE Planning division provided hydrology, construction oversight, and engineering expertise. USACE Operation & Maintenance division constructed the kicker dike adjacent to the Federal levee in the project area. David Owen of River Springs Partners removed the estimated 54,000 cubic yards of bedload material from the river. Mr. Owen contributed the cost of the removal of the material, screening, and replacement of oversize, estimated at $210,000, as in-kind to the project. Wyoming Game and Fish Department provided fish survey and water quality data on the ponds.

[1] Excavation design attached

CONSTRUCTION

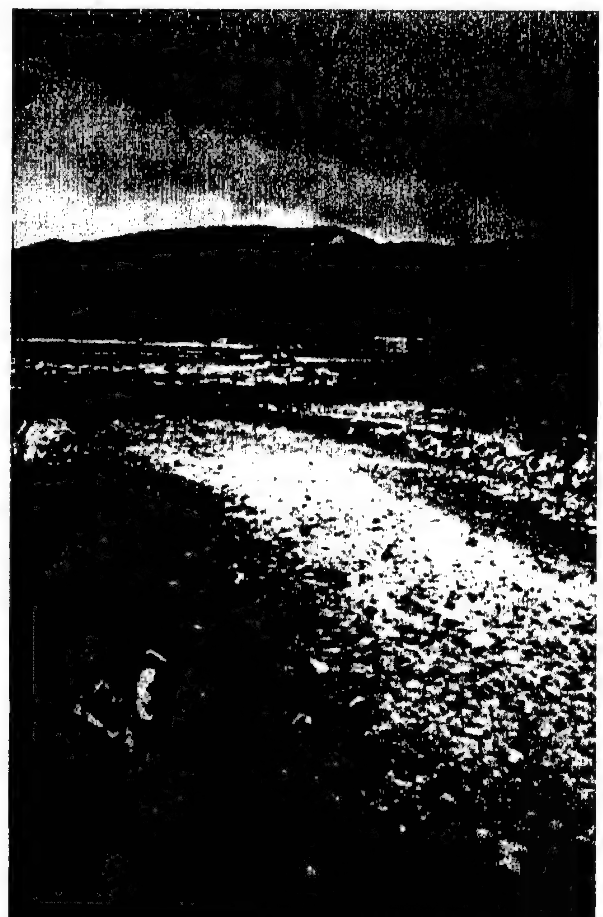
Debris Fences -

Beginning November 1, 1998 the Demonstration Project was initiated with the three phases, main channel excavation, brush/debris fence construction, and pool excavation commencing simultaneously. Elevations and placement of the termination points of each of the five fences were established by U.S. Army Corps of Engineers (USACOE) personnel with the brush/debris fences being completed by Teton County staff near the end of November. The excavation phase of the project was completed by mid-February.

The cost of the fences was considerably higher than the original estimate of $15,000. The final cost was $26,893.75, approximately $12,000 over estimate. It should be noted that the estimates for this phase of the project were very speculative due to the experimental nature of the fences. Given the hands on experience constructing these restoration components on the relatively small scale of the demonstration project, cost estimates for the much larger restoration areas can now be made with a much greater degree of accuracy.

Pools -

Upon an area field survey by USACOE and Wyoming Game & Fish personnel in which the pools were to be excavated, it was decided to reduce the number of pools to be excavated from six, as originally planned from aerial photography, to three. Consideration was given to existing topography, stability of the historic overflow channels and the level of disturbance to vegetation that would be experienced during excavation. A total volume of 6334 cubic yards of material was removed from the three pools. While only one of the pools has any direct contact with the river, groundwater filled each of the pools with the lower pool experiencing enough infiltration that it established a steady outflow of 1-2 cfs. These pools were periodically checked throughout the winter by Wyoming Game & Fish personnel to determine if oxygen levels in the water would be sufficient to support overwintering fish populations.



The site pictured above is of the lower pool at the end of an abandoned channel

Corps of Engineers personnel supervising the excavation of the lower pool

Completed lower pool prior to runoff

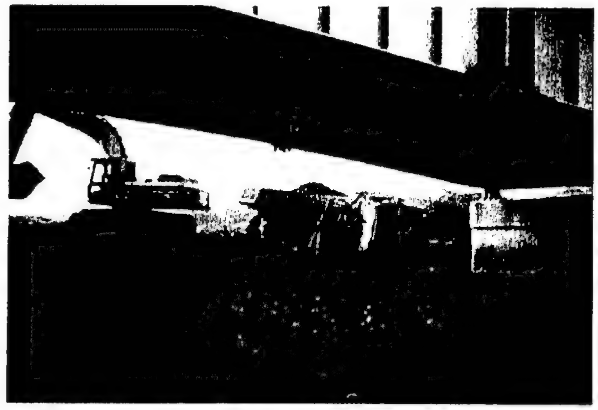
While the initial cost of the excavation of the pools was well below estimates, two elements arose that should be considered in future projects of this nature on multi-jurisdictional managed lands. The pools were located on Bureau of Land Management property and therefore the excavated material could not be sold. An arrangement was made with Teton County to stockpile the material at a privately owned quarry in the area in which the County held a lease agreement. The material would then be used in future river restoration or maintenance projects as required. The terms of the agreement and an ongoing legal action required that personnel be placed at the gated entrance to insure that material was only taken into the quarry and not removed. Also, an easement for the haul road had been obtained with the landowner on whose property the road crossed. A condition of the easement was to have personnel placed at a gate on the property to insure that livestock did not pass. The addition of personnel created an unforeseen cost for the excavation.

These "before and after" photos are of the middle pool area. This area is about midway down the secondary overflow channel on the island. The water shown in the left photo appeared during excavation and is being supplied by groundwater percolation. This minimal level was sustained throughout the winter.

Channel Management **-**

Prior to commencement of the main channel excavation USACOE and District

personnel performed a field survey to establish the specific dimensions of the excavation. Cross sections surveyed at 100 foot intervals, extending from 300′ south of the Wilson bridge to 1200′ north of the bridge, were recorded and will serve as the basis for future monitoring. The initial draft plan for the excavation was based on the desired final dimensions of the finished channel modification and had not taken into account the instability of the material within the channel during spring and summer flows. After review of the field survey it was decided to decrease the surface area of the excavation by approximately one third given the amount of material in the proposed excavation site. New plans were provided to Owen's Excavation Inc. and the excavation was begun.



Channel management activity required additional heavy equipment in the immediate area of the Wilson Bridge. Aggradation of material was so excessive that the riverbed was lowered up to thirteen feet in this area. A small bulldozer was used to push the material out to the backhoe so that it could be loaded into the dump trucks

After the material was removed from under the bridge, the operation moved upstream to some of the larger gravel bars.

To accommodate the special conditions of the 404 permit and to address concerns of the Department of Environmental Quality and the Wyoming Game & Fish Department, the excavation of the channel was accomplished in two phases. The first phase included the installation of a 36″ corrugated metal pipe to accommodate an existing flow in a side channel of approximately 100 cfs that was on the west bank of the river. The placement of the pipe served several purposes. It allowed for dry access to the eastern side of the excavation while allowing for a continued flow through the side channel in case fish were present. Once the pipe was in place the flow was then reduced to approximately 25 cfs by the placement of rock in the upper inlet of the side channel. This measure incrementally dewatered a majority of the side channel thereby insuring all work would take place in the dry, while allowing for a minimum flow necessary (and minimal impact) for any aquatic organisms present.

The process of gradual dewatering one half of the excavation at a time provided a method of extracting bedload material "in the dry" while minimally impacting water quality and existing fish populations.

Work was initiated on the downstream end of the eastern half of the excavation and proceeded to the upstream end. Once the material had been removed down to the desired elevation on the eastern half of the excavation, the streamflow down the western side of the excavation was allowed to flow into the excavated eastern half effectively dewatering the western half. The shifting of the minimum flow was accomplished with little impact to water quality in the main stem of the river. Periodically throughout the duration of the project water quality testing was performed by TCD staff above and below the work site using an EPA approved DH integrated sampler. Sampling methodology included working across a section of the main channel of the river moving the sampler vertically through the water column at 10 foot intervals. The cross section sampled on the downstream end was 100′ below the confluence of the main channel of the river and the side channel to provide an appropriate mixing zone. Samples then were sent via Federal Express to the Wyoming State Lab for analysis for Turbidity and Total Suspended Solids. A maximum increase limit of 10 NTU's has been established as a condition of the 404 permit. Results from analysis determined that turbidity did not exceed an increase of more than 1 NTU and suspended solids increased an average of 1-2 mg/l, far below the established thresholds.

After the side channel flow had stabilized in the eastern side of the excavation, work began on the downstream end of the western side. Unfortunately as work began on this section little snow (which inhibits ground frost) had fallen in the area and two weeks of subzero temperatures drove the frost level in the ground down about five feet. This slowed progress considerably and it became apparent that the February 1 stop work order, due to the Bald eagles in the area, would have to be exceeded in order to facilitate placement of the screened oversize cobble (4" and larger) back in the excavated area to provide armoring. After a consultation with Pat Diebert of the U.S. Fish & Wildlife Service, it was agreed to extend the work window primarily due to the location of the permitted year round gravel processing site which was closer to the nests than the extraction site. The excavation was completed with a total of 36,208 cubic yards being removed.

MONITORING

Monitoring of the demonstration project area is a vital component of the overall study of restoration techniques on the Snake River system. Data obtained will be used to make adjustments to the restoration methodology. Once the impacts are more clearly understood and the effectiveness is validated, the tools can then be applied more effectively in the other Study areas along the Snake River. A number of separate monitoring methods are utilized to observe the variety of restoration measures used in the area.

Debris Fences -

The function of the debris fences was to catch floating debris, creating areas of diminished velocity both immediately up and down stream of the fence. In these areas the relatively slow velocities created an area for the sediments suspended in the runoff to drop out and accumulate. As runoff flows recede, this sediment deposition creates a nutrient rich environment in which shrub/scrub vegetative and grass species can establish viable populations quickly. This growth in turn stabilizes the sediment and the soil building process begins. Soon tree species begin to colonize the area which will provide long-term bank stabilization. The fences were built to afford "50 year" protection after which natural growth will provide protection.

To establish sediment gain / loss, elevations were surveyed between the fences both pre and post runoff. These elevations combined with photo points and vegetation transects will provide evidence of both the quantity of sediment captured and rate of vegetative colonization.

Prior to the 1999 runoff event this area was composed primarily of cobble and gravels. Post runoff observations reveal that silts and nutrient rich sediments were deposited.

Pools -

The pools were dug to create fisheries habitat for resting, overwintering, and spawning. Fish population surveys have been completed by Wyoming Game & Fish personnel in this area. These surveys will be repeated in the future and will show any increase in quantity of fish due to the improvements in the area. It will be difficult to justify the changes in population in the area to the pools. Monitoring that directly correlates to the success pool habitat includes recording the rate of sediment accumulation through survey, flow calculations, dissolved oxygen measurements in the winter, and visual observation.

Upper Pool nine months after construction.

Channel Management -

In an attempt to understand the causal effects of bedload movement and erosion with channel and point bar formation several survey tools were used. Through the use of aerial photography the extent and rate of destruction of island habitat in the area has been documented from 1944 to the present. Using recent photography, two foot contours of the area have been plotted to be used as a baseline in order to determine the increase in the total area of the island. Additionally, cross sections of the river at 100 foot intervals from 300′ below the Wilson bridge to 1800′ above the bridge are surveyed during low flows each year. Once analyzed, this data should provide some indication of the effects channel excavation and placement of debris fences have had on channel/point bar geomorphology and hydrology. Photo points were also used to provide a visual record during runoff events.

FINDINGS

Debris Fences -

The primary function of the debris fences was to trap debris thereby facilitating the deposition of sediment. As they meet their primary function the fences act as catalyst for the island creation process that naturally occurs in the Snake River floodplain. This restoration tool can then be used in areas where islands were historically located and to augment the few remaining islands to enlarge them to their historic proportions. Evidence of the success of the fences is indicated in this panorama series of photos.

6/4/99

The upper part of the brush fence area provides solid evidence of its ability to capture silt. The first series was taken at river flows of 15,900 cubic feet per second. Water had first appeared the day before in the fenced area and is "subbing" up e.g. ground water pooling at this point. Note the distance the main channel of the river is from the end of the fences. At low flow the edge of the channel was at least 40 meters out from the fence in this location.

6/25/99

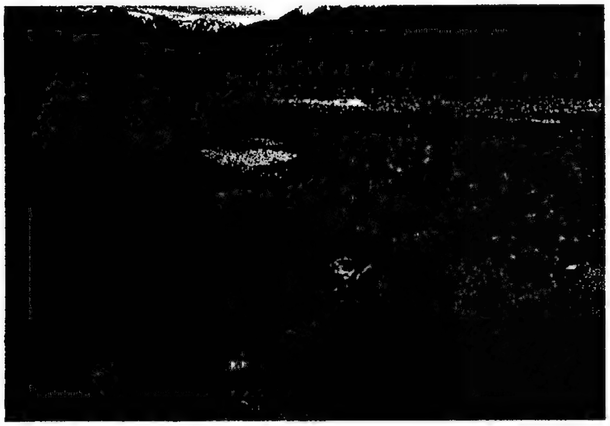
The second series (17,200 cfs) was taken the first day that the site could be accessed after peak runoff (20,600 at 6/18/99). The fenced area has had river flows passing through for about 15 days at this point. Note the heavy current impinging on the end of the fence at left and the main channel of the river moving into the fenced area but being diverting back away by the fences.

7/9/99

Spring runoff flows have receded to 8,800 cfs in this series. Significant deposition of nutrient rich sediment (up to 18" in most areas) has occurred with the fences functioning as expected.

While the debris fences functioned as expected, they also provided an unanticipated level of direct protection to the area. Not intentionally designed to endure a direct impingement from high velocities, up to 15 feet per second in this case, they performed beyond expectation. Prior to runoff the closest edge of the main channel of the river was 40 meters from the fenced area. During runoff the main channel shifted from river right to river left entering the fenced area from the side rather than from upstream. Acting like kicker dikes, the fences kept the main energy of the flow away from the island. While there was some damage to several of the fences, (four of the outer posts (6" well casing) were bent in half) if they had not been in place there is a high probability that the lower one third of the island would have been destroyed.

Other debris fence observations of note:



The photo at left illustrates the typical composition of the riverbed in the area of the debris fences prior to runoff. Cobble and gravels constitute the majority with some sand and a little silt. The vegetation is comprised of cool climate grasses and weeds.

This photograph at right, taken June 21st @ 19,600 cfs, shows the fences underwater. The flow at upper end of the fenced area did not have significant velocity, estimated at 2 feet per second. The middle and lower end however experienced high energy impingement, estimated between 10 – 15 feet per second as the main channel avulsed toward the island. You can see the standing waves created by fences three and four near the center of the photo.

Debris fences # three and four at left are acting similar to kicker dikes and deflecting the main energy of the flow (19,000 cfs) away from the island. The hydraulic "head" created by the debris lodged in the fences and impeding flow through the fence and creating "back pressure" was responsible for keeping the flow from entering the area in between the fences.

This is a good representation of the type of material captured by the fences. Note the deep scour hole at the end of the fence. While the end of this fence was damaged from the high flow, the result created excellent fish habitat.

Pools -

Two of the three pools were positioned in an overflow channel that did not receive direct flow from the river for a majority of the year. There was evidence of very high ground water infiltration which would keep water levels in the pools at acceptable levels throughout the year. There was some concern of how well the pools in the overflow channel would stand up to direct flows from the river. The third pool was placed off channel but it was expected that it would fill from groundwater recharge. In summary, all pools performed as expected during the runoff period.

A second concern was how well the pools would support overwintering populations of fish. Wyoming Game & Fish personnel monitored the pH and dissolved oxygen levels throughout the winter. The results, shown below, indicated that the lower and upper pools had favorable water chemistry to support fish, while the middle pool did not. No supported hypothesis has yet been developed to provide an explanation for the low dissolved oxygen levels in the middle pool.

SNAKE RIVER COE DEMONSTRATION PROJECT - AREA 9 PONDS

WATER	DATE	AIR	H20	DO	pH	REMARKS
Lower Pool	12/11/98	26F	42F	7 ppm	None	ICE FREE / CLEAR WATER
	1/12/99	35F	40F	10 ppm	8.2	ICE FREE / CLEAR WATER
	2/16/99	36F	ICE	6 ppm	7.7	2" CRUD ICE / CLEAR WATER
	3/17/99	55F	ICE	7 ppm	7.5	EDGE ICE FREE/CLEAR WATER
	4/14/99	45F	47F	9 ppm	8.7	ICE FREE/CLEAR WATER
	5/14/99	50F	46F	7 ppm	8.7	SAME FLOW
Middle Pool	12/11/98	26F	ICE	8 ppm	7.7	2" ICE / CLEAR WATER
	1/12/99	35F	ICE	2 ppm	7.8	7" ICE / CLEAR WATER
	2/16/99	36F	ICE	3 ppm	8.7	7" ICE / CLEAR WATER
	3/17/99	55F	ICE	11ppm	8.7	6" ICE / CLEAR WATER
	4/14/99	45F	52F	8 ppm	8.3	EDGE ICE FREE/CLEAR WATER
	5/14/99	50F	46F	7 ppm	8.7	WATER FLOW INTO POND
Upper Pool	12/11/98	26F	ICE	8 ppm	7.7	1.5" ICE / CLOUDY WATER
	1/12/99	35F	ICE	9 ppm	8.5	1/2 ICE FREE / CLEAR WATER
	2/16/99	36F	ICE	9 ppm	8	4" CRUD ICE/ CLEAR WATER
	3/17/99	55F	ICE	10ppm	9	4" CRUD ICE / CLEAR WATER
	4/14/99	45F	50F	9 ppm	8	EDGE ICE FREE/CLEAR WATER
	5/14/99	50F	50F	9 ppm	8.9	CLEAR WATER

While the lower pool was transformed by erosion early in the runoff period on the lower end into a back eddy by the main river for several weeks, when the river levels dropped a natural coffer dam formed and an adequate water elevation was retained in the pool. The middle pool's configuration did not change although some deposition of sediment occurred during runoff. While there was no direct inlet to the upper pool, during high water outflow discharge was observed as high as 3 – 4 cfs. There was no turbidity observed in this pool at any time. Please refer to field notes on the following page.

Field Notes

5/29/99 - 18,000 cfs
Overflow channel @ 70 cfs. Pool #1 lower end eroding out.

6/1/99 - 15,000 cfs
Overflow channel @ 5 cfs.

6/7/99 - 15,600 cfs
Overflow channel @ 35 cfs.

6/14/99 – 15,700 cfs
Overflow channel @ 5 cfs but outflow @ 20 cfs indicating significant groundwater infiltration.

6/15/99 - 18,000 cfs
Overflow channel @ 10 cfs, outflow @ 25 cfs. Lower and middle pools have water backing in from the channel at the lower end. Main river channel is avulsing to the east.

6/17/99 - 19,400 cfs
Overflow channel @ 15 cfs. Lower pool filled completely with backwater from river.

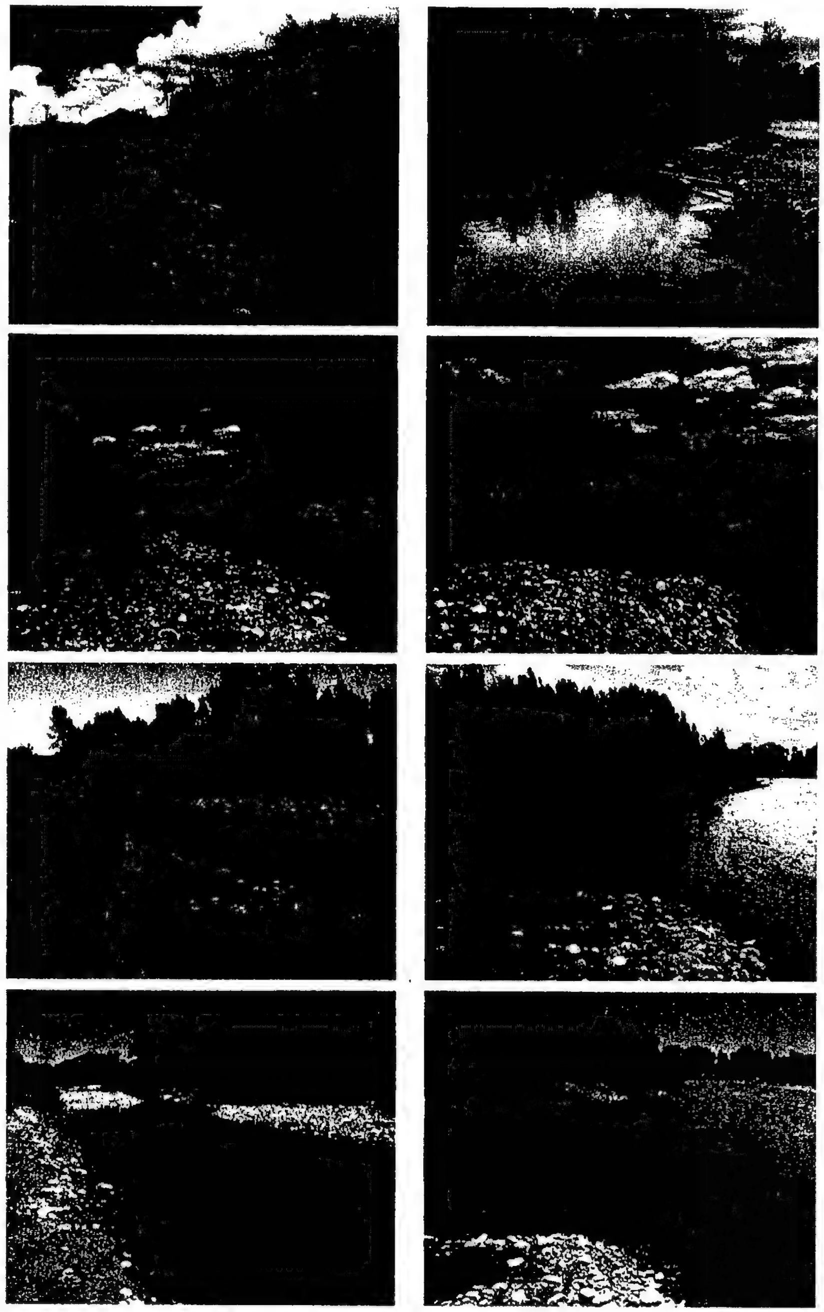
6/19/99 - 20,100 cfs
Overflow channel @ 25 cfs.

6/23/99 - 18,900 cfs
Major inflow reduction although outflow from lower pools is down only slightly. Low turbidity indicates

Strong groundwater infiltration. Preliminary observation indicates lower pool did not headcut and lower reach is intact! Observed fish rising in lower pool.

7/1/99 - 9,800 cfs
Inflow absent, good outflow.
Sandbar formed at the mouth of lower pool enhancing water storage.

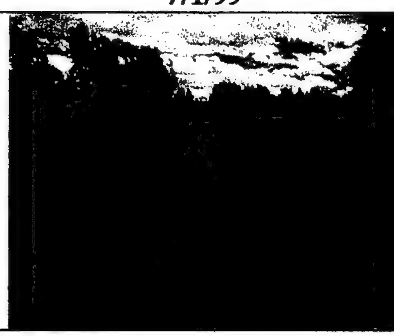
Lower Pool Study Photos



The middle and upper pools experienced a far lesser degree of change in structure as evidenced in the study photos on the following pages.

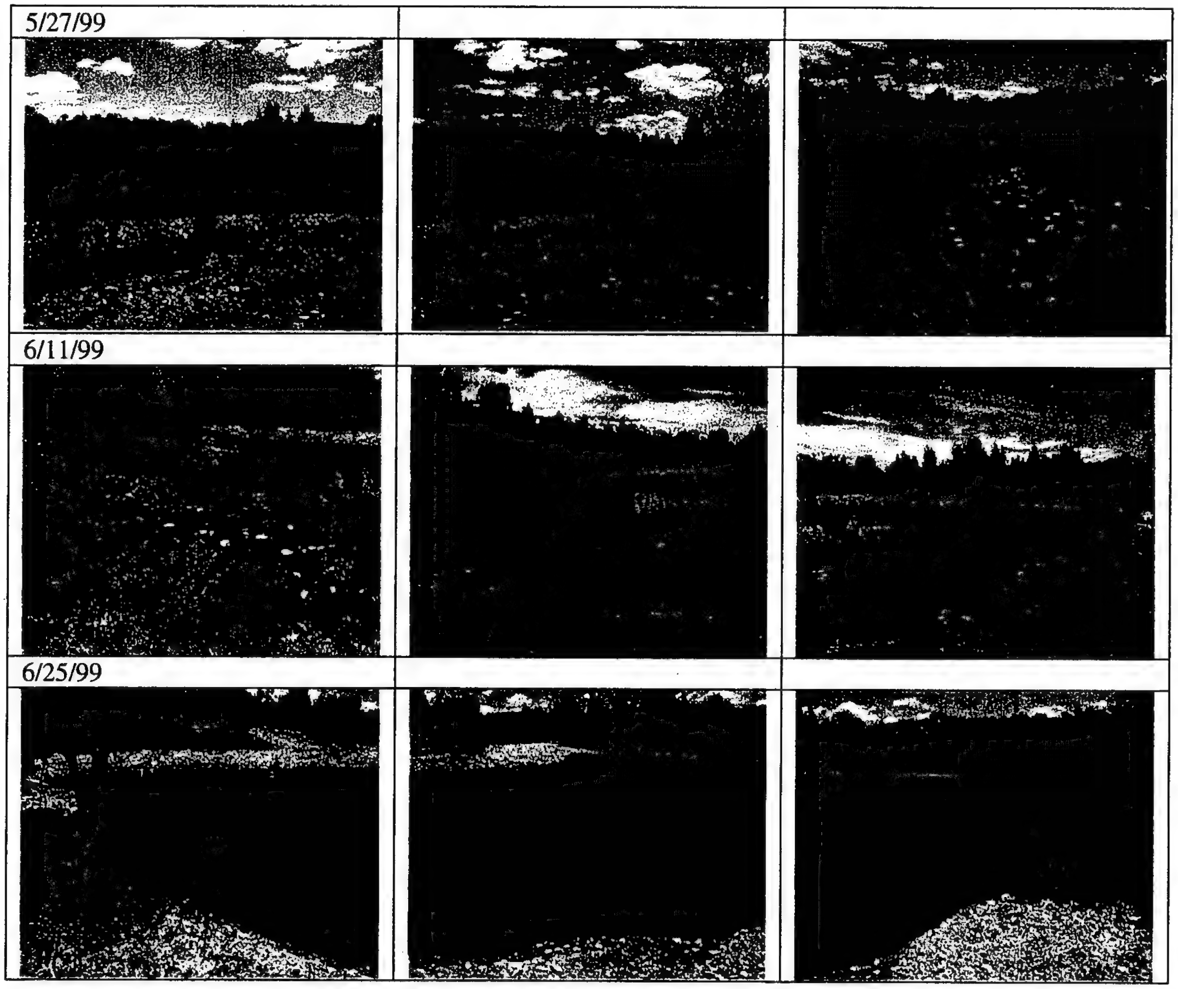
Middle Pool Study Photos

This is the largest pool covering almost one acre. At the far end in the photograph a deep hole was dug as a resting area for fish that is out of the main current. The area in the foreground is much shallower and constitutes the overflow channel floodway.

5/27/99	6/4/99	6/11/99
		
6/23/99	**7/1/99**	**7/13/99**
		

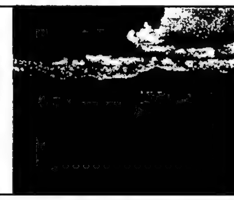
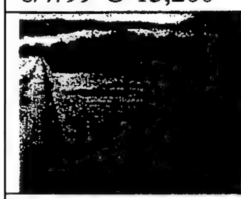
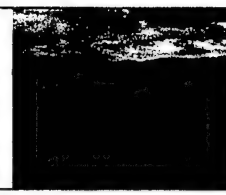
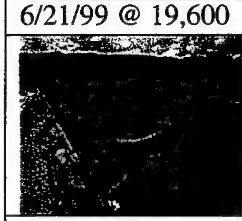
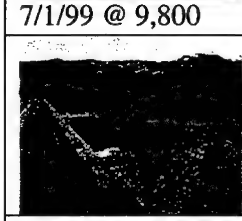
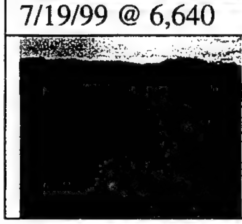
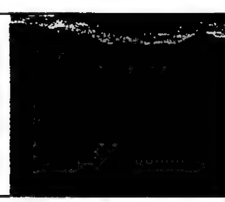
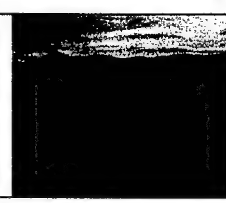
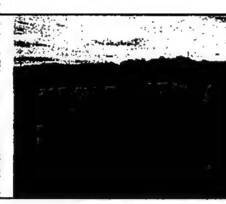
Upper Pool Study Photos

The following three panoramas were taken from different perspectives but are still fairly representative of the upper pool's configuration. In the second series you can see the overland outflow from the pool. While there was no direct inflow into the pool groundwater infiltration supplied a fresh source of water. Currently this pool is being utilized for waterfowl and no fish have been introduced. Wyoming Game & Fish personnel are considering stocking the pool as it has proven to be able to support fish. Additional cover will have to be used to protect the fish from the Osprey and Bald eagles in the area.



Channel Management -

When the islands are restored within the levee system, the river channels must be deepened to accommodate the loss of floodway conveyance created by more surface area. In river restoration efforts, opportunities exist to increase flood capacity while concurrently attempting to stabilize the channel through planned bedload extractions. In the demonstration project area it was desired to have a single channel adjacent to the island and have it split into two channels below[2]. Note in the following photo point record, the main channel established itself as planned. Unfortunately the secondary channel excavation in front of the boat ramp filled back in with bedload material almost immediately upon commencement of runoff. However, even though the channel management activity was not totally successful, a great deal of data was compiled which when analyzed will provide important information on river hydrological and geomorphological processes.

5/25/99 @ 10,700				
				
6/7/99 @ 15,200				
				
6/21/99 @ 19,600				
				
7/1/99 @ 9,800				
				
7/19/99 @ 6,640				
				

The debris fences and pools are located on the island in the background on the right side.

[2] see attached excavation plan

The Good

by Jim Morrison

Restoring riverside habitat damaged by man may require a man-made solution.

From my vantage point, the winding Snake River disappears into the rocky, snow-crusted promontories of the Teton Mountains, a view reminiscent of Ansel Adams' often reproduced 1942 landscape portrait.

For a first-timer to this remote part of Wyoming, it's a jaw-dropping vista. But it doesn't take Bill MacDonald of the U.S. Army Corps of Engineers long to explain to me that his trained eye sees devastation, not beauty.

"This is the ecological ghetto," he says firmly, pausing along the river, just outside Jackson Hole and south of Grand Teton National Park.

MacDonald, along with Rik Gay of the Teton County Natural Resource District and Pam Lichtman of the Jackson Hole Conservation Alliance, is standing in a dry channel. Behind them rise a stand of mature cottonwood trees and a thicket of scrub willows on what becomes an island annually when melting snow creates a spring torrent. Such islands—a vital habitat—are increasingly rare along this stretch of the Snake River.

When Ansel Adams photographed the Snake River and Teton Mountain Range in 1942, lush vegetation covered the riverbanks.

Flood

Jim Morrison

Barren stretches of white river cobbles along the Snake River have replaced the thick stands of trees seen in Ansel Adams' 1942 photo.

We're here to inspect a unique attempt to help revitalize the river and recreate those islands and grow new stands of trees. Time is short. Rik Gay figures that without action all the islands and small pools along this section of the river will disappear within 20 years, leaving vast, sterile stretches of riverbed cobbles.

The Taming of the Snake

What transformed the lush riverbanks of Adams' portrait into the wasteland of today? The taming of the Snake, specifically 22 miles (35 kilometers) of sinuous rock levees built along here during the 1960s to control floods and protect ranchers' property. Indeed, the levees have saved pastureland and, more recently, lavish homes. But they also have radically altered the ecology, confining what was a wild, braided, multichanneled river and wiping out islands and riparian (riverbank) areas, home to trees, birds, fish, and even moose.

Gone, too, are the seasonal floods that for centuries recharged the river's food chain. Cottonwoods need the spring flood cycle to grow. The few that remain, like those on that island, bear silent witness to another time. Now, barren stretches of whitened river cobbles have replaced the thick stands of trees in Adams' half-century-old photograph.

Lichtman, a hydrologist with the Jackson Hole Conservation Alliance, explains why the trees are disappearing. "Flooding is a disturbance regime," she says. Like fire, it rejuvenates an ecosystem even as it destroys.

In recent years, conservationists have begun to better understand and trumpet the virtues of a river's ebb and flow, its respiration. The realization, of course, is not new. Ancient Egyptians outlawed flood control, recognizing the importance of the Nile River's life-giving deluges.

But on large stretches of rivers like the Snake, the Mississippi, and the Missouri, levees and dams stymie seasonal flooding. So state, federal, and private organizations have begun investigating ways to reverse or mitigate their environmental damage, balancing on the high wire stretched between the needs of humanity and the needs of nature.

Giving Something Back

What was once inconceivable is now being done. Dams in North Carolina, Maine, Vermont, and California have been dismantled in the last 2 years in attempts to renew rivers. In Washington state, the Elwha Dam and its upstream companion, the Glines Canyon Dam,

are scheduled for demolition in a last-ditch attempt to restore salmon and trout runs on the Elwha River (though so far Congress has declined to appropriate the funds). Some breached levees on the Missouri were not rebuilt after the 1993 floods. In Idaho, controversy rampages over whether to remove four dams from the lower Snake River.

The project I'm here to inspect with MacDonald, Lichtman, and Gay on the upper Snake River, about 50 miles (80 kilometers) south of Yellowstone National Park, is less controversial. It won't require the demolition of dams or leveling of levees, but conservation officials say their unusual technique will make this area look more like the river in Adams' photograph.

Part of the solution being implemented is what MacDonald calls "BioFences." Yes, fences rising from the dry river bottom—as incongruous a sight as the monolith on the moon in the movie *2001: A Space Odyssey*. They were created by pounding well casings 17 feet (5 meters) down into a dry channel, then stringing heavy steel cable and what ranchers in these parts call "cattle panels"—sections of fence used to create temporary corrals.

Gay and MacDonald say the fences will corral debris like branches and logs in an attempt to slow the rushing spring waters and cause sediment to drop, preserving and perhaps even enlarging that endangered island. In a few years, willows—followed by cottonwoods—should take root in the soft sediment. If the BioFences work, MacDonald says they will be used on other swift flowing portions of the river.

In addition to the fences, Gay supervised the dredging of three small pools just off the winter channels that he hopes will serve as spawning pools for the local cutthroat trout.

The fences and the dredging are not elegant solutions to the habitat loss. But, for now, they're the only options. "Removing the levees, that would really be the only way to get it totally natural," says Les Cunningham, a corps hydrologist also along on the tour. "That probably is not politically acceptable." Not acceptable to ranchers, the owners of million-dollar estates that have sprung up along the river, or residents of the nearby town of Wilson, which would have been washed away without the restraining levees.

Gay, who moved to the area in 1984, has canoed, kayaked, and rafted the river often in the last 15 years and watched it change dramatically as the islands with trees began to disappear. "We can't remove the influence we've already exerted on this river. It's not reasonable to think that we could," says Gay. "But it's our responsibility to do something. We need to be able to give something back to this river."

Lessons Learned

"Ten thousand river commissions, with the mines of the world at their back, cannot tame that lawless stream, cannot curb it or confine it, cannot say to it, 'Go here or go there,' and make it obey; cannot save a shore which it has sentenced; cannot bar its path with an obstruction which it will not tear down, dance over and laugh at."

—Mark Twain, 1882

Twain's admiration was for the power of his beloved Mississippi River. More than a century later, the floods of recent years show how little has changed, despite billions of dollars spent constructing levees and dams. The Mississippi and the Missouri floods of 1993 wiped out farmlands and even some small towns.

For people accustomed to living in the floodplain, the floods were a bitter, painful

reminder of a river's unforgiving strength. Property damage in 1993 alone was estimated at $12 billion, while the government spent more than $5 billion for disaster relief.

For the rivers, though, those floods were "normal" respiration, replays of an ebb and flow going back before recorded time. For scientists, the floods were another piece in a puzzle that has become increasingly clear: healthy rivers periodically need to spill into their floodplains.

"There's no question that there's [now] a much better understanding of the role that floods play in the health of rivers than there was before the great flood of 1993," says Scott Faber, a floodplain expert with American Rivers, a nonprofit organization dedicated to saving rivers.

In the West, rivers like the Snake, the Missouri, and the Mississippi are huge vacuum cleaners, collecting trees and leaves and other debris and pulling them into the main channel of the river. There, that debris breaks down and becomes the primary food source for aquatic life. Studies also indicate that fall and spring migrations of waterfowl are timed to flooding because of the feeding.

Scientists have discovered that dams and levees confound organisms adapted to the historical rhythms of rivers. For instance, dams trap sediment and organic debris that would flow downstream. Levees, meanwhile, confine the energy of a rushing river between two walls. The rechanneled water wipes out island and riverbank vegetation faster than it can regrow and prevents the creation of side channels, pools, and wetlands vital to fish, birds, and trees.

"When you wall off a river from a floodplain, it's as if you were closing up all of the McDonald's in the neighborhood, eliminating all of the access a river needs to its food supply," says Faber.

Catfish, trout, and other native species also need to migrate out of the main channel to reproduce. When those side channels don't exist because of dams or levees, the fish have nowhere to go for their amorous adventures.

"A flooded floodplain is the drive-in movie equivalent in the fish world," says Faber. "The lack of flooding is one of the reasons many species in the Missouri and Mississippi are suffering decline."

While farmers and residents spent the aftermath of the 1993 floods trying to rebuild their businesses and homes, biologists fanned out on stretches of the Missouri River to measure how the flood affected the ecosystem. Some counted the vegetation in a 20- by 40-inch (50- by 101-centimeter) plot. Others watched birds, noting their eating habits and activity. Still others dragged nets in the river, trying to snare fish larvae. In all, more than 30 field technicians and researchers from state and federal agencies spent 5 years in tedious research to determine the effects of the big flood. The scientists found the flood dramatically recharged the river's life.

They also acknowledged, however, the difficulty of making today's Missouri resemble the teeming-with-life "Big Muddy" that captivated Lewis and Clark in 1804. Less than 20 percent of the river's vast floodplain in Missouri is amenable to restoration, scientists wrote in a September 1998 article published in *BioScience*. What they proposed was the creation of a "string of beads" along the river by acquiring and rehabilitating key patches of habitat. The idea is that not all the floodplain needs to be opened to flooding to revitalize the river.

Doug Helmers of the Missouri office of the Natural Resources Conservation Service coordinated the 5-year study on the ecological effects of the 1993 flood. Helmers is optimistic

At right: BioFences built on the Snake River are designed to trap silt and debris, helping to enlarge and preserve the river's islands.

Below: Bill MacDonald of the U.S. Army Corps of Engineers talks about the river's ecosystem with Pam Lichtman, a hydrologist with the Jackson Hole Conservation Alliance. In the background loom the snowy caps of the Teton Mountain Range.

both photos by Jim Morrison

the beads concept can strike a balance between the needs of agriculture and the needs of nature.

"I'm not sure that we're going to be able to completely restore an entire ecosystem," he adds. "I think what it will do is at least maintain some of the biological integrity of the system and maybe even bring back some of the historic habitat types that occurred along the river"—habitats like cottonwood and willow forests and the side channels fish use for spawning.

A Shift in Attitudes

Faber of American Rivers is realistic about what is driving the first baby steps toward restoring some rivers by removing dams and levees. "I think the biggest factor is the recognition of the real risk of floodplain development."

Because the building of dams and levees encouraged floodplain development, flood damage has actually grown this century. The United States spends more than $4 billion annually for disaster recovery due to floods.

Paying that bill forced federal agencies to reexamine their polices. For the first time, claims Faber, the United States is spending more money to move people out of harm's way than it

Pools like this one have formed near the river, thanks to the rehabilitation projects. One day, fish may use it as a spawning ground.

Jim Morrison

is to maintain dams and levees. After the 1993 floods, several small towns, including Valmeyer, IL, took federal assistance to relocate on higher ground rather than rebuild in the floodplain.

Most dramatic is the shift by the Army Corps of Engineers, which has spent seven decades trying to control Mother Nature. The corps set aside $25 million last year and a total of $325 million over 6 years for what it calls "nonstructural flood control projects"—voluntary relocation of people living in floodplains and land acquisition.

Still, broad ecosystem solutions are difficult. For most of this century, levees and dams have encouraged settlement in floodplains. Few towns and cities protected by levees are likely to move. Spring floods could make it impossible to drain fields in time for planting some years, an additional hardship on already hard-pressed farmers.

So small steps are being taken instead. Conservation groups and the government are restoring riparian habitat a few thousand acres at a time. For instance, levees along a 2,600-acre (1,040-hectare) section of the Iowa River, overtopped 18 times in 66 years, weren't repaired after the 1993 flood when farmers decided to sell out to the National Fish and Wildlife Foundation (NFWF), a 15-year-old nonprofit organization partially funded by Congress.

The NFWF is working with the U.S. Fish and Wildlife Service and the Department of Agriculture to buy thousands of acres of agricultural land along the Mississippi, Iowa, and Missouri rivers and return them to wetlands.

"Changing the way flood control is done is a huge step toward improving river health in the United States," says Moira McDonald, the NFWF's director of wetlands and private lands initiative.

Each dam or levee removal is bound to be a battle. But McDonald says using flood control dollars to purchase land and allow nature's flood control—wetlands and uninhabited floodplains—to take hold ultimately will save money and preserve the environment. "We continue to pass really destructive flood control projects [like levee building], particularly in the South, but in other parts of the country we're seeing examples of flood control projects that will have long-term environmental benefits," she adds. "I'm optimistic."

A Man-made Solution for a Man-made Problem

On the Snake River, Bill MacDonald is talking about changing attitudes. The levees, he notes, were conceived nearly 40 years ago. "It was a different mentality then," he says. "[The thinking was] we've got to conquer nature and provide a living for ranchers up against the short season and the severe weather."

His comment reminds me of something I'd read a few days earlier in a story about dam building. It quoted from a 1965 Bureau of Reclamation booklet that encapsulated the prevailing mood of the times: "Man serves God. But Nature serves Man."

MacDonald is confident man's latest intrusion into nature's wondrous ways will work on the Snake. "Man has designed levees for flood protection. Now, we're going that much further to protect and restore the natural environment," he says.

The final decision rests with Teton County and the Natural Resource District. Rik Gay figures construction of the fences on four sites, each between 1 and 2 miles (1.6 and 3 kilometers) long, will cost about $5 million, and restoring the islands will be a 50-year job. But that's what he recommended this past fall after watching the fences and pools during the spring floods.

Last year was what researchers call a high flow year on the upper Snake. The BioFences, says Gay, got hammered as the snow melt raced down the river. Four of the 70 well casings, ones near the center where the river forged a new channel, were folded over by the force. But the fences worked. They saved a portion of the island and gathered about 18 inches (46 centimeters) of silt where new growth soon emerged—only to die during the summer drought.

"You could tell from current upstream we would have lost another third of the island if the fences hadn't been there," says Gay. "We didn't expect them to deflect the main current. But, they did. So we got a bonus out of it."

Ideally, about 50 sites along the Snake River would get the fences and have pools dredged, but Gay says he doubts Congress will appropriate the funds.

Creating more man-made intrusions—even if it's to restore the river—rankles Pam Lichtman of the Jackson Hole Conservation Alliance. She is resigned to the political realities restricting restoration. She knows the levees won't come down. Still, she worries about the effects of further tampering with nature.

In her opinion, the ecosystem decline on the Snake began because man tried to manage the river. Now, the corps and local officials are saying the way to repair the resulting damage is to micromanage the river.

"I'm the first one who hopes this works," Lichtman tells MacDonald. "But sometimes I wonder... what we get messing around with the river."

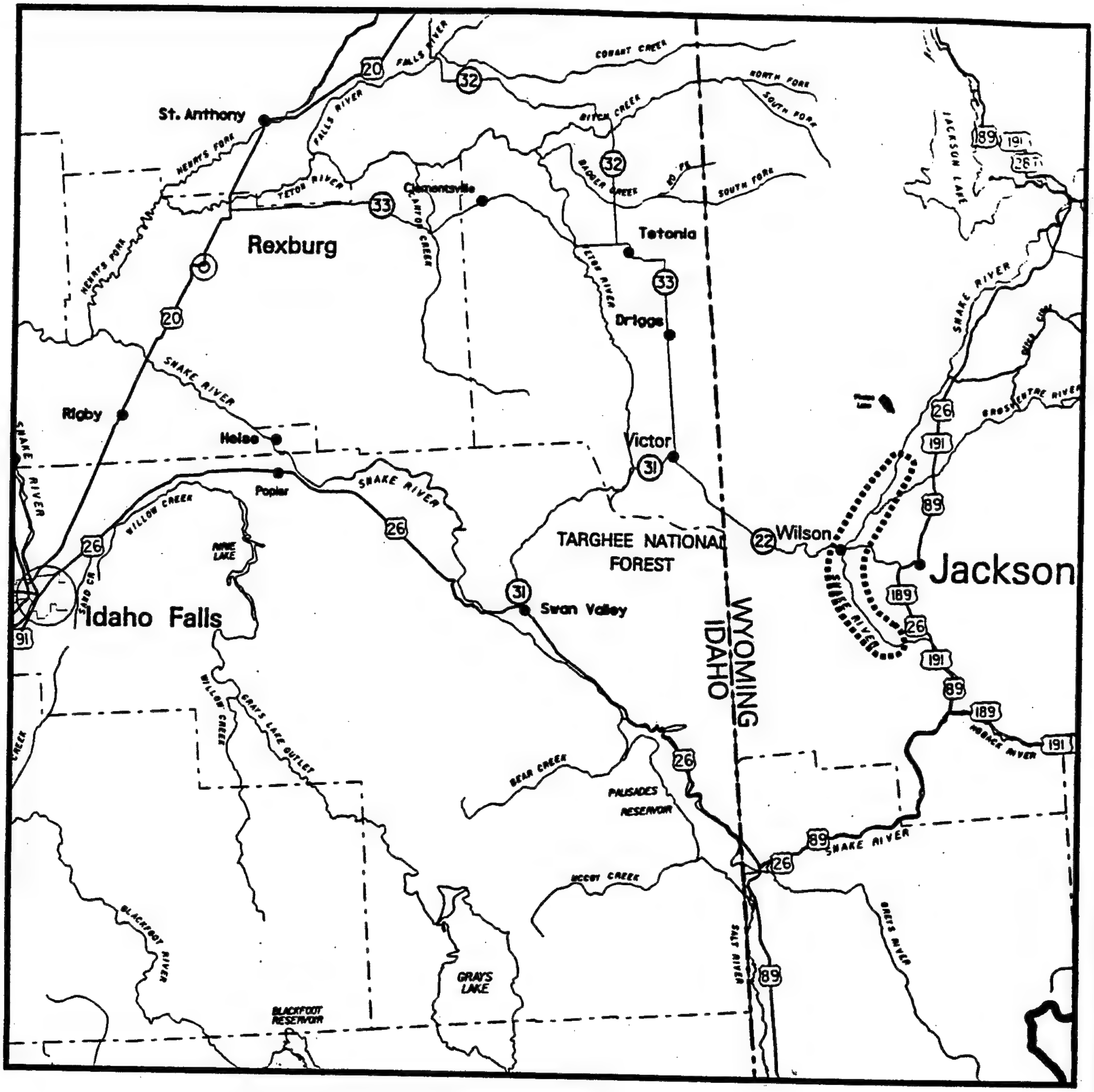
The next morning, with the sun peaking over the horizon, I drive north from Jackson Hole and into Grand Teton National Park. To the west, the Tetons are dusted with snow, though the season's first storm hasn't blanketed the sagebrush of the high prairie.

I pull into a lookout and walk to the edge. Below, the river bends, its banks obscured by thick stands of pines and cottonwoods.

No levees were built this far upriver. The view is as striking as an original Ansel Adams print. And just as rare. CA

Jim Morrison is a frequent contributor to *Compressed Air*, and his work also appears in *Smithsonian, The New York Times, George,* and *This Old House.*

PLATES

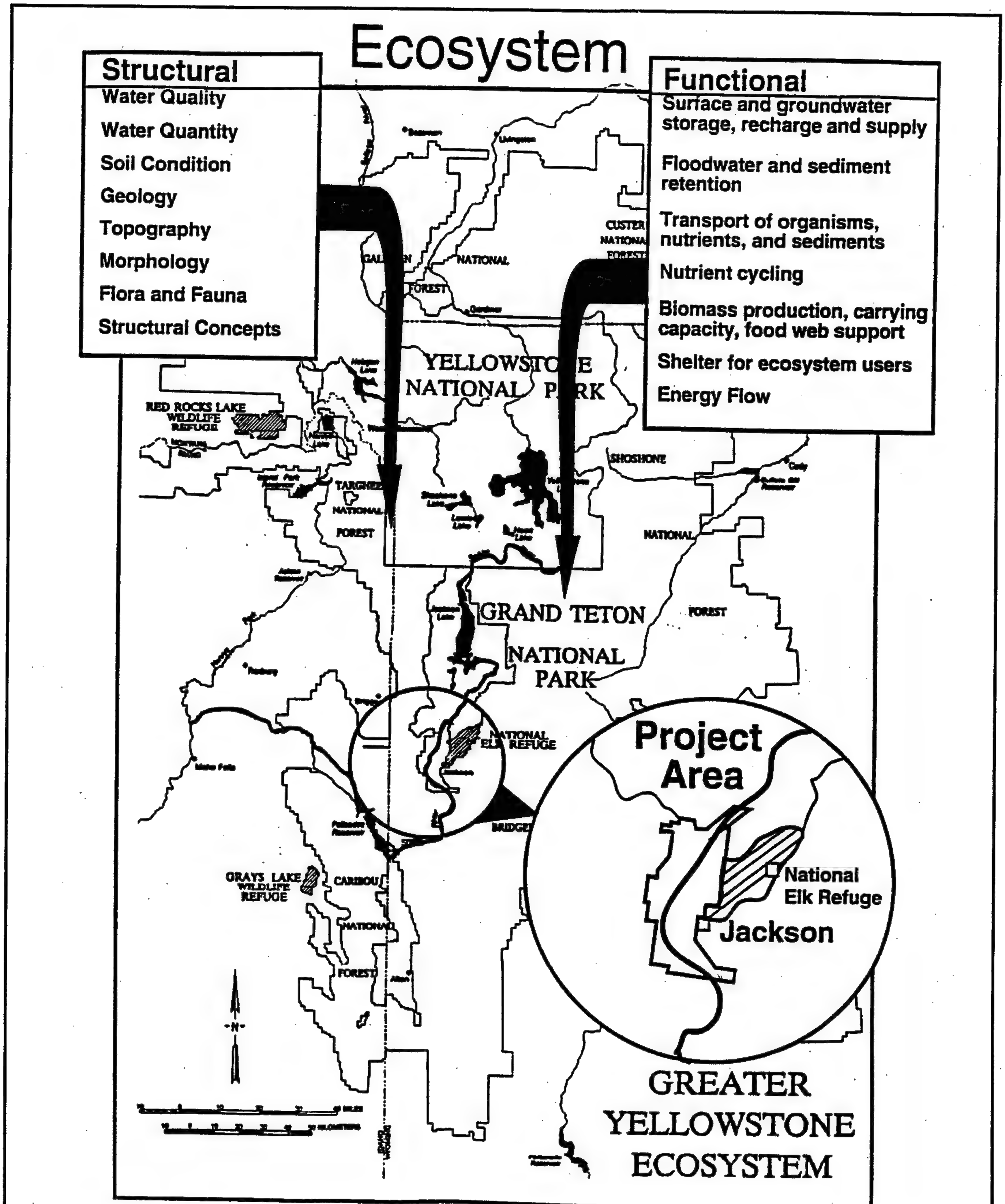


PROJECT LOCATION

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 1:
Vicinity Map

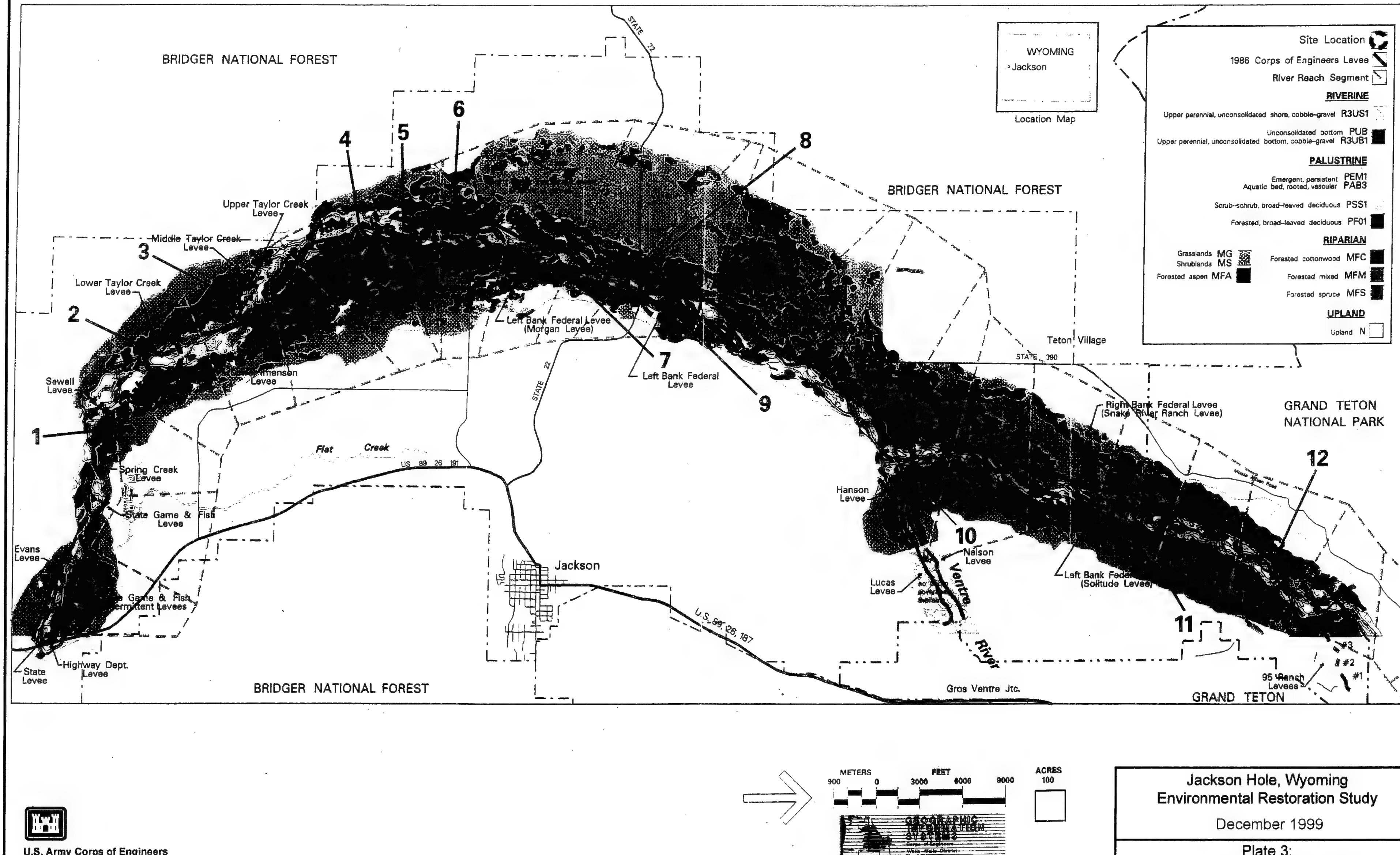
U.S. Army Corps of Engineers
Walla Walla District



Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 2:
Project Location Map

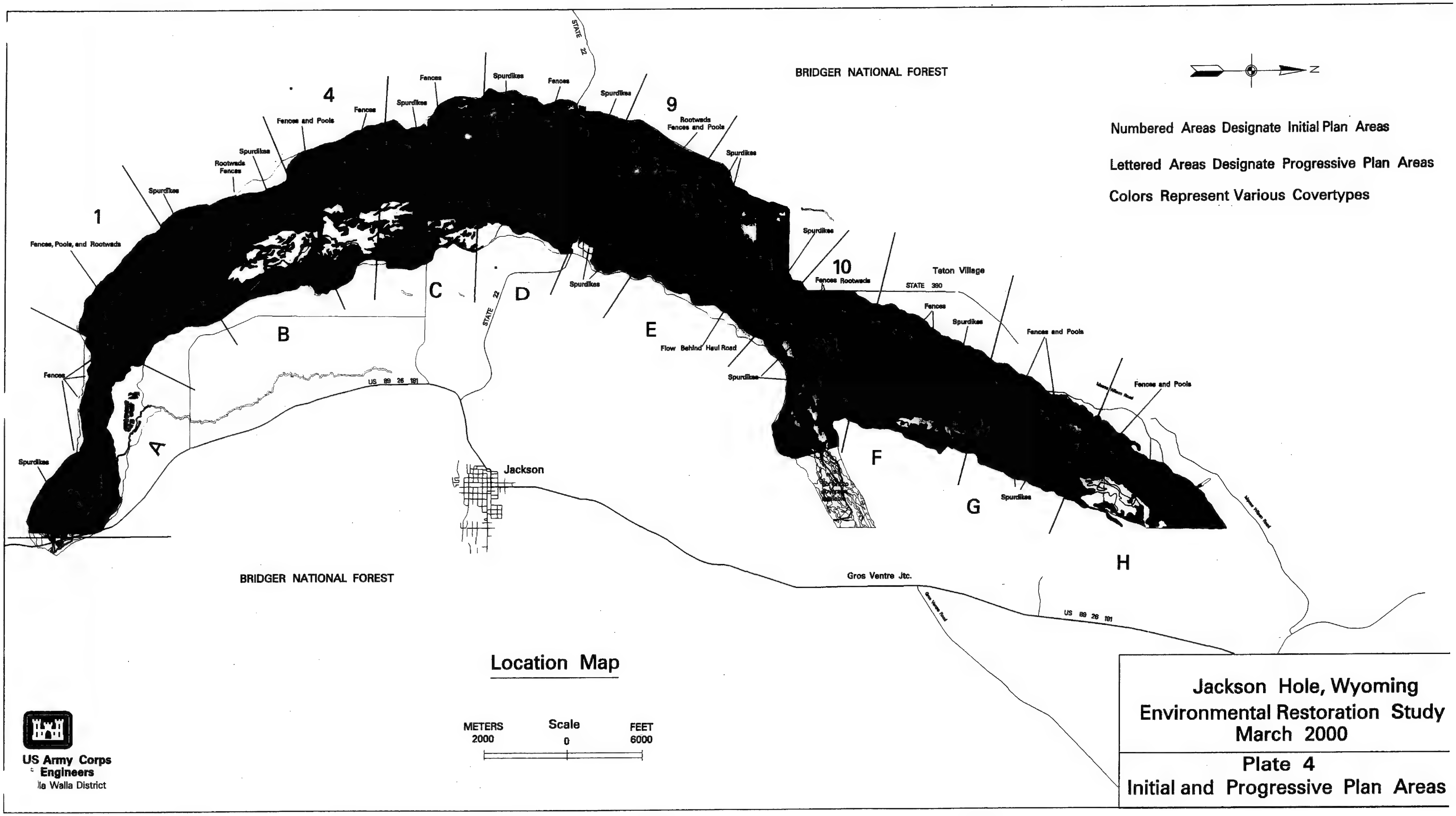
U.S. Army Corps of Engineers
Walla Walla District



U.S. Army Corps of Engineers
Walla Walla District

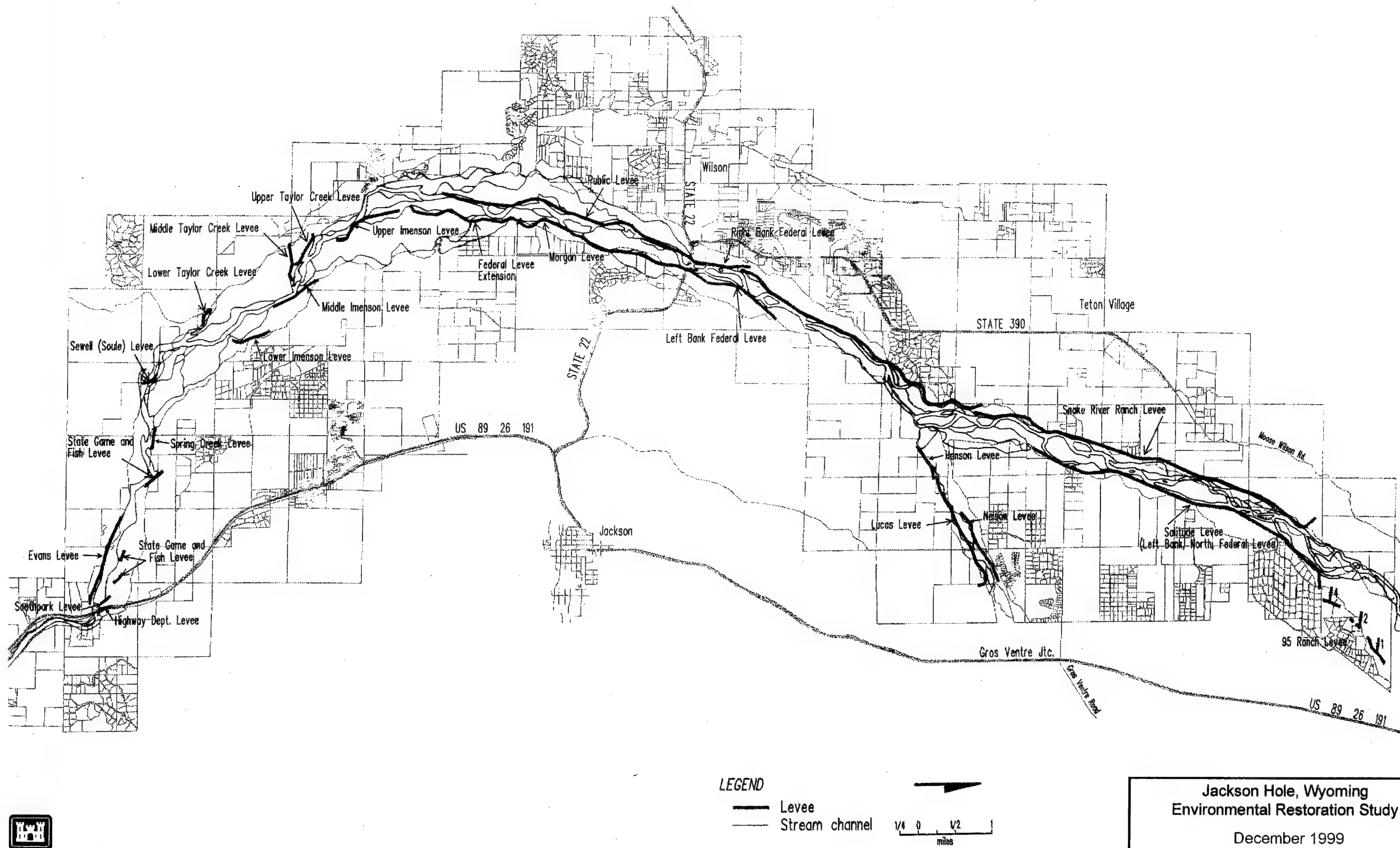
Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 3:
12 Reconnaissance Sites



Jackson Hole, Wyoming
Environmental Restoration Study
March 2000

Plate 4
Initial and Progressive Plan Areas

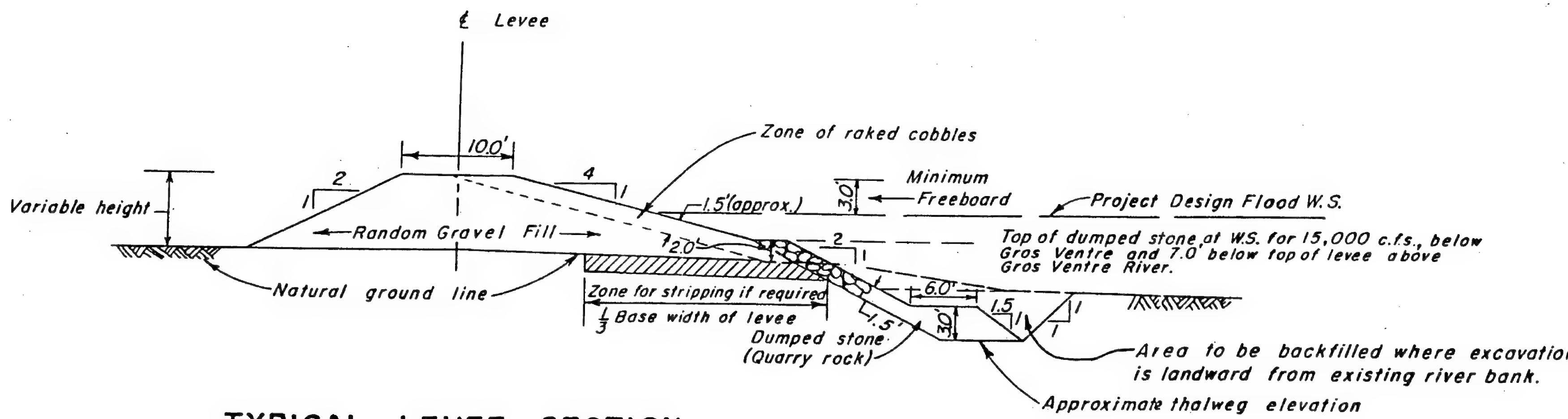


U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

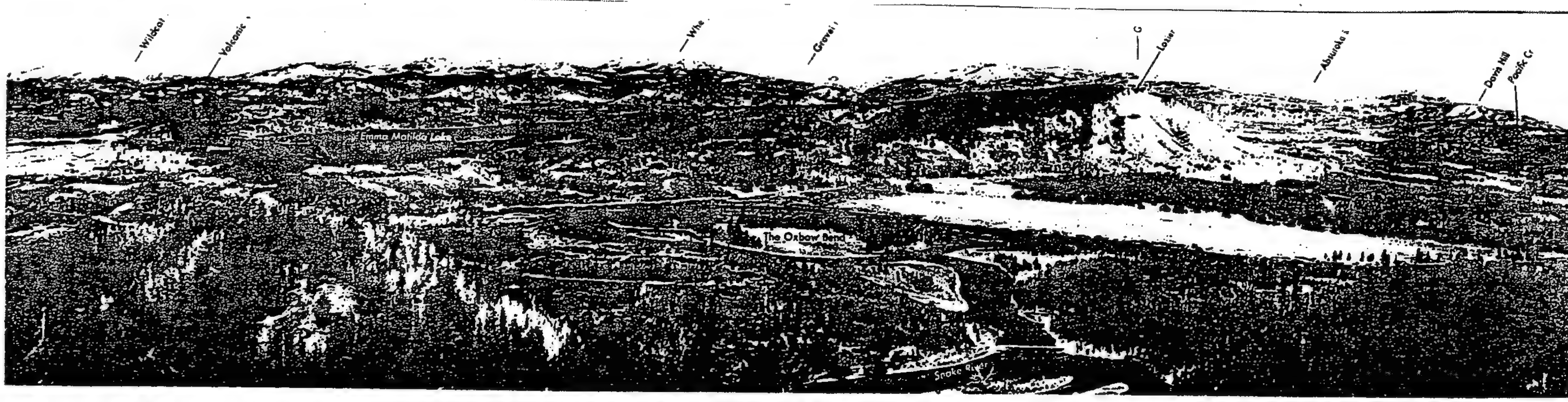
Plate 5:
Existing Levees



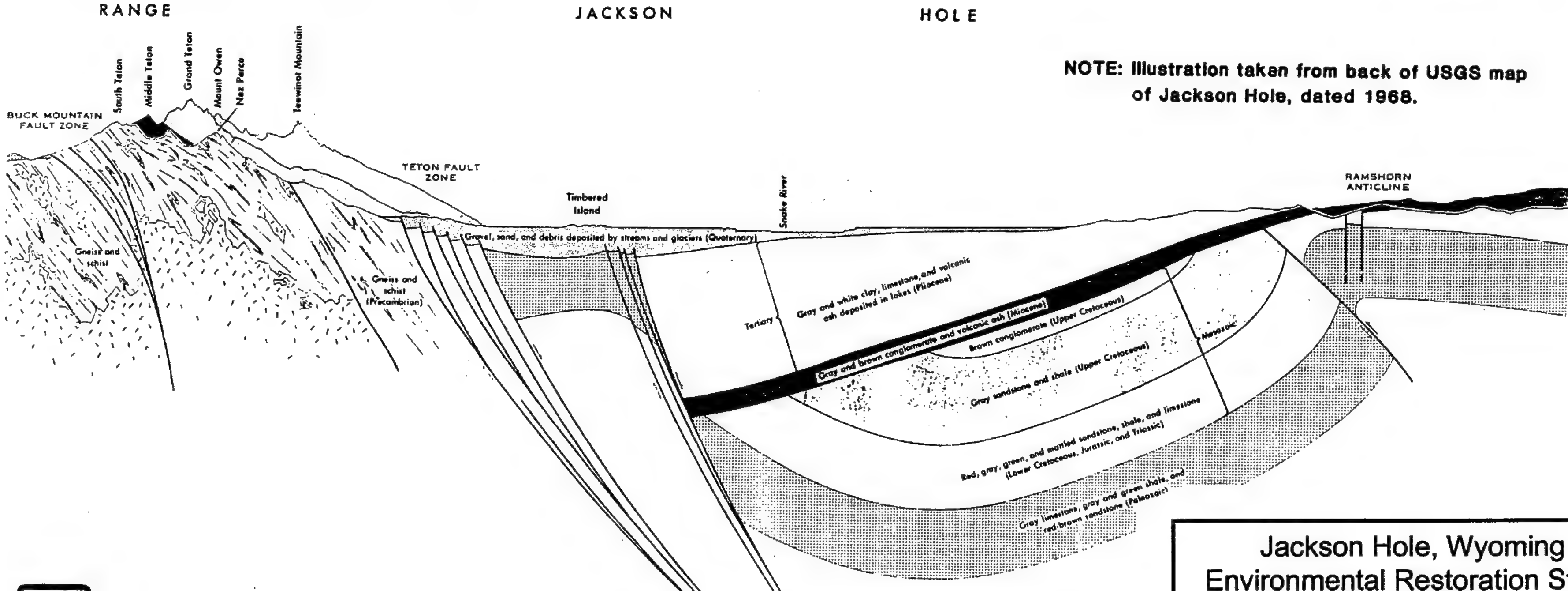
TYPICAL LEVEE SECTION

U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming Environmental Restoration Study December 1999
Plate 6: Typical Levee Section



VIEW NORTHEAST FROM SUMMIT OF SIGNAL MOUNTAIN
Emma Matilda Lake is ponded behind glacial moraines. Most of the peaks and ridges are underlain by sedimentary rocks of Mesozoic and Tertiary age. Position of volcanic vent near Two Ocean Lake is indicated.

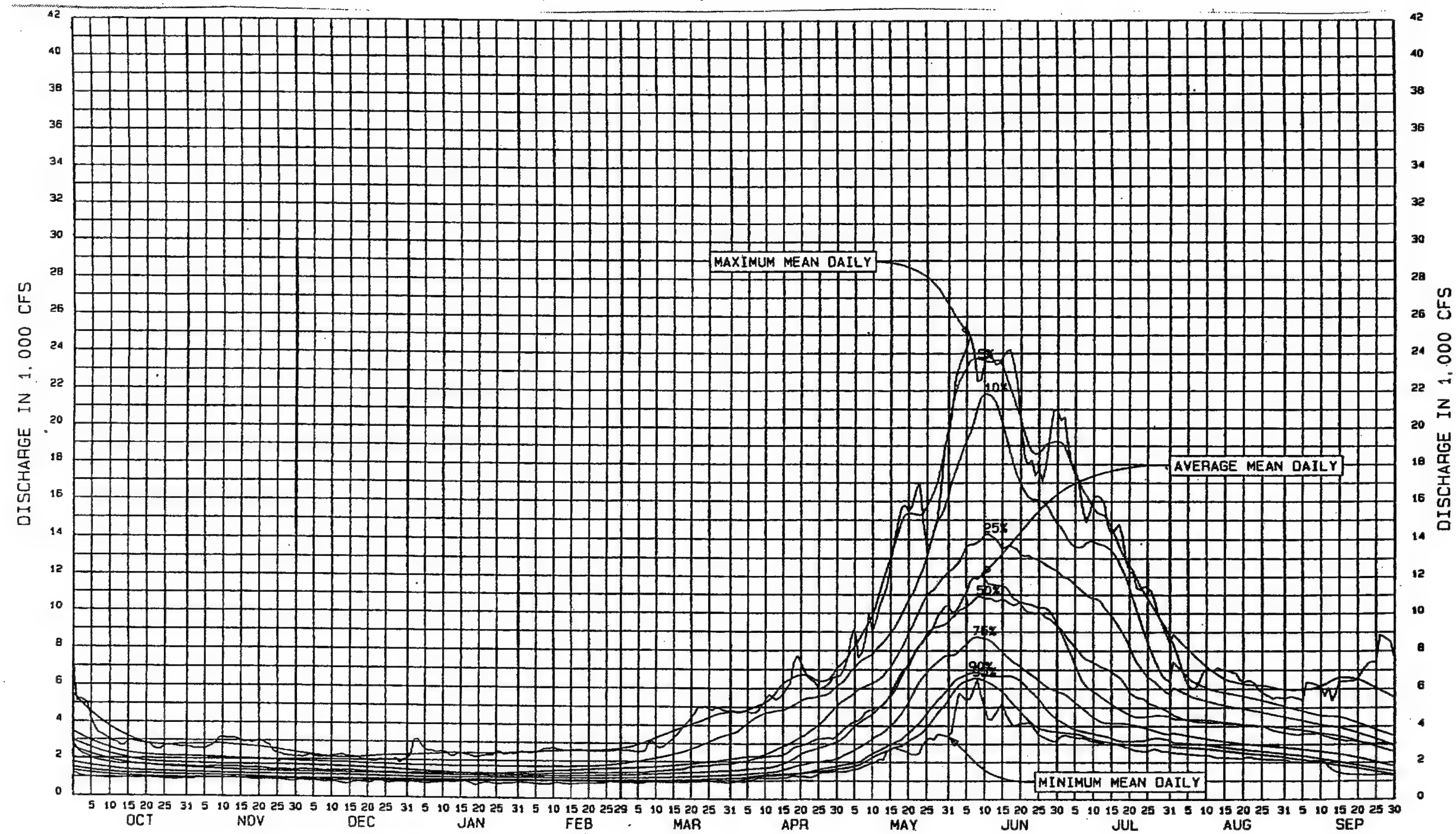


NOTE: Illustration taken from back of USGS map of Jackson Hole, dated 1968.

U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 7:
Teton Fault Block Tilting



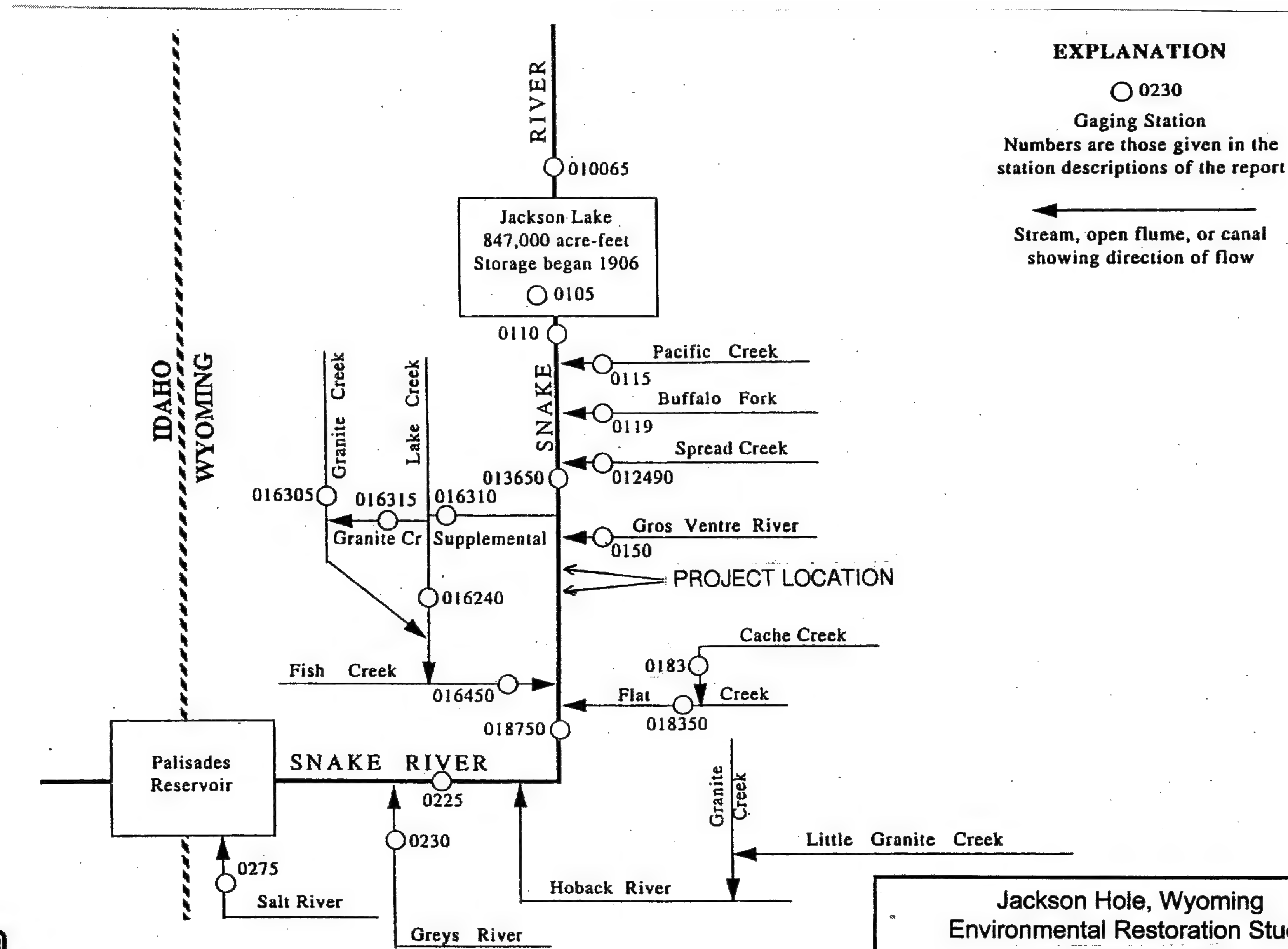
NOTE:

1. PERIOD OF RECORD IS DEC 1975 THROUGH MAY 1997

U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

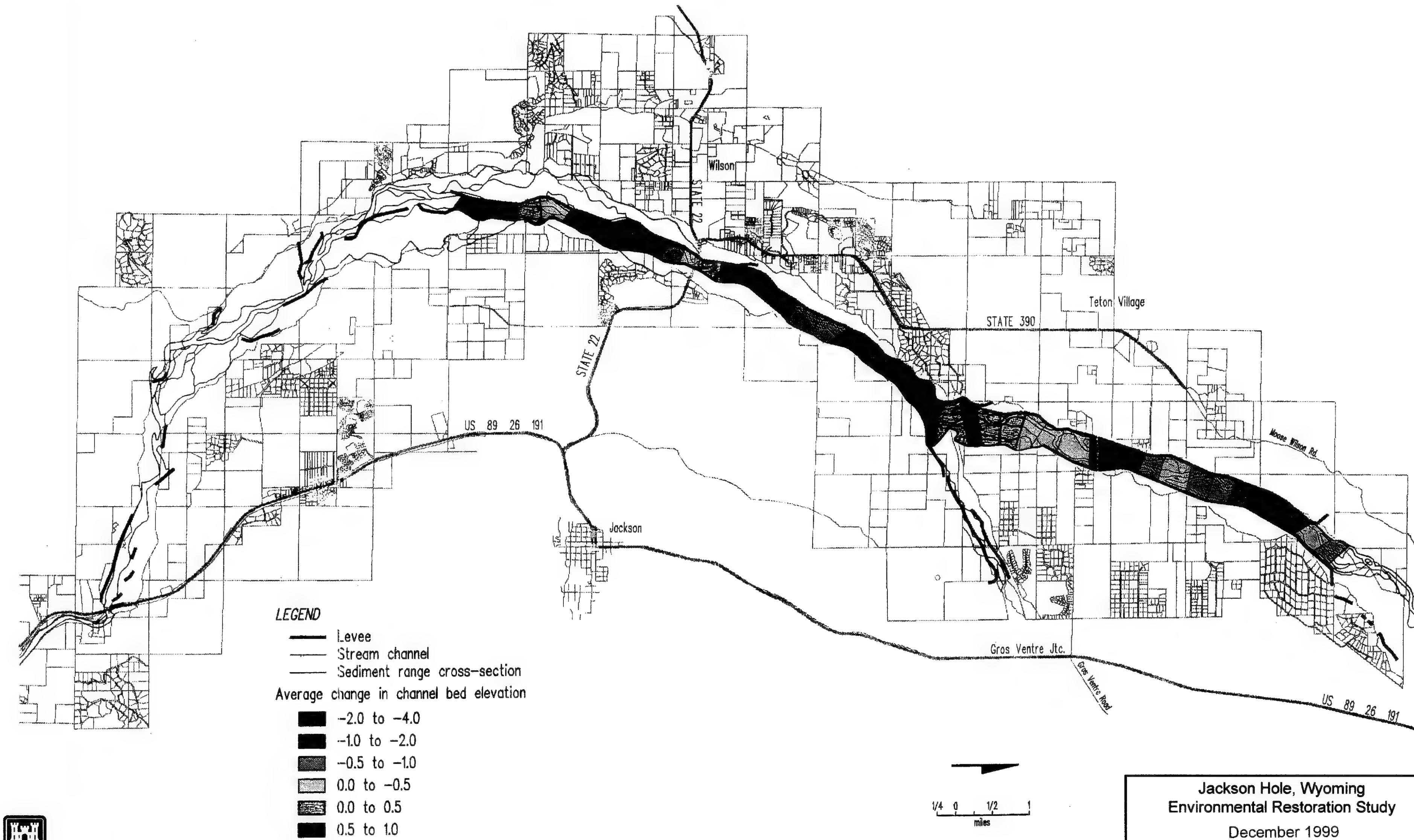
Plate 8:
Summary Hydrographs



Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 9:
Stream Gaging Network

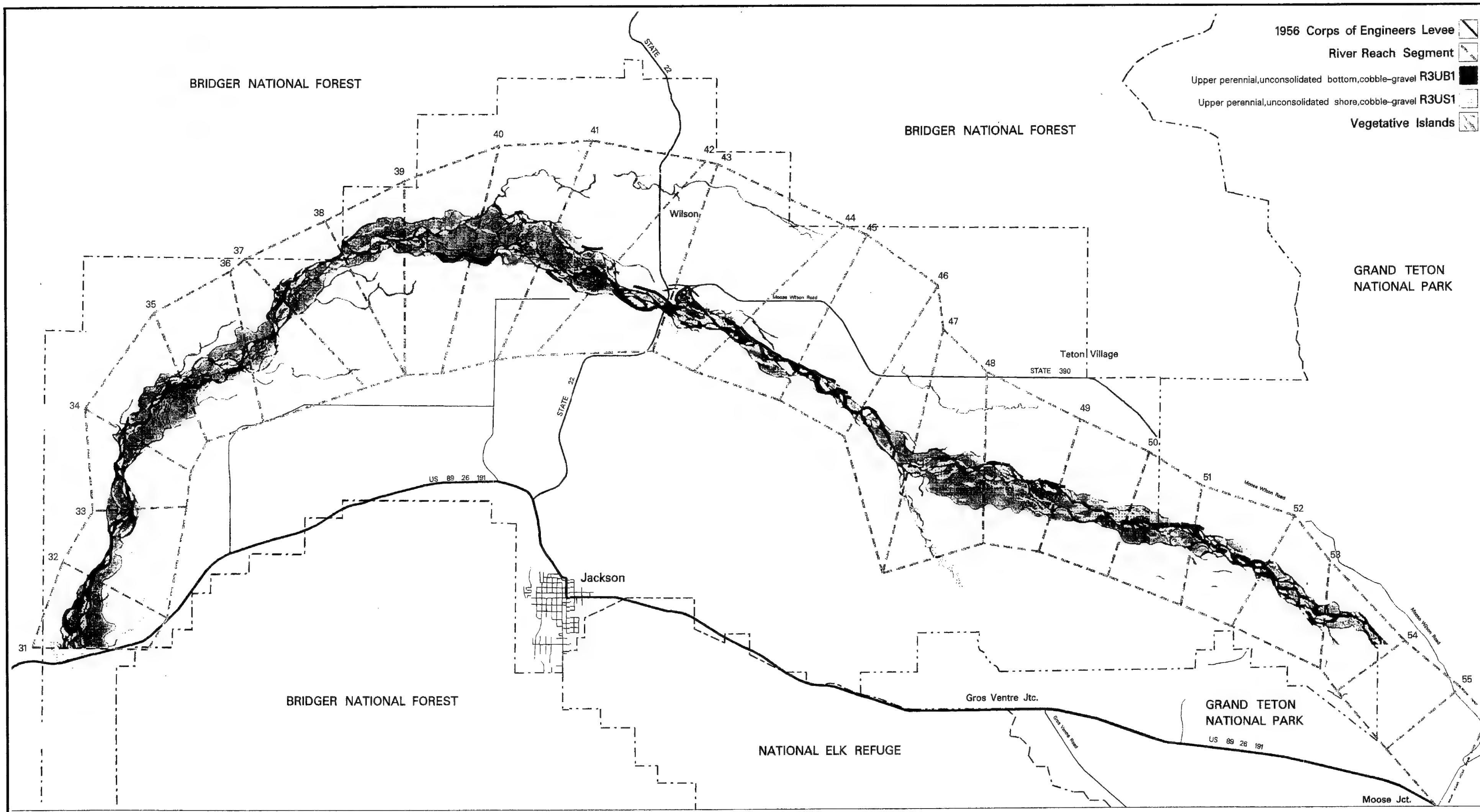
U.S. Army Corps of Engineers
Walla Walla District



U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 10:
Average Erosion or Deposition, 1954-1988

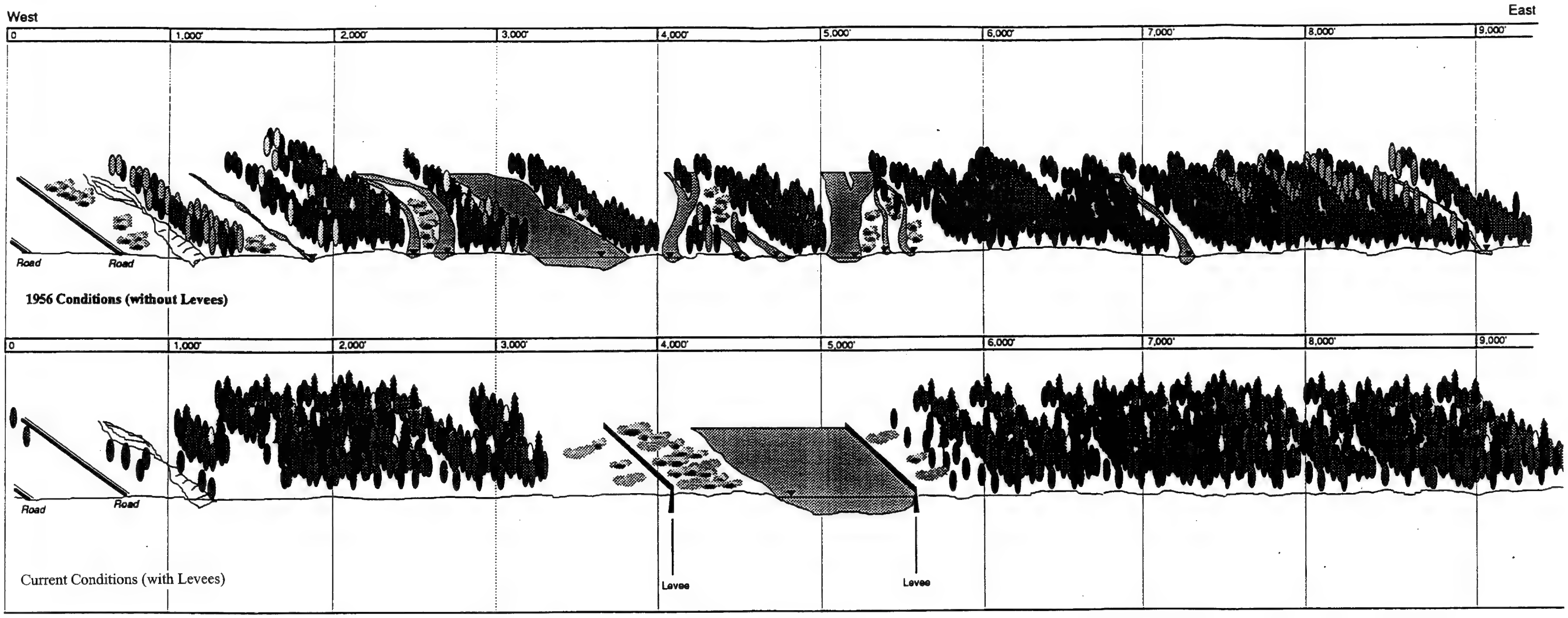


U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

Plate 11:
Main Channel Hydrology, 1956

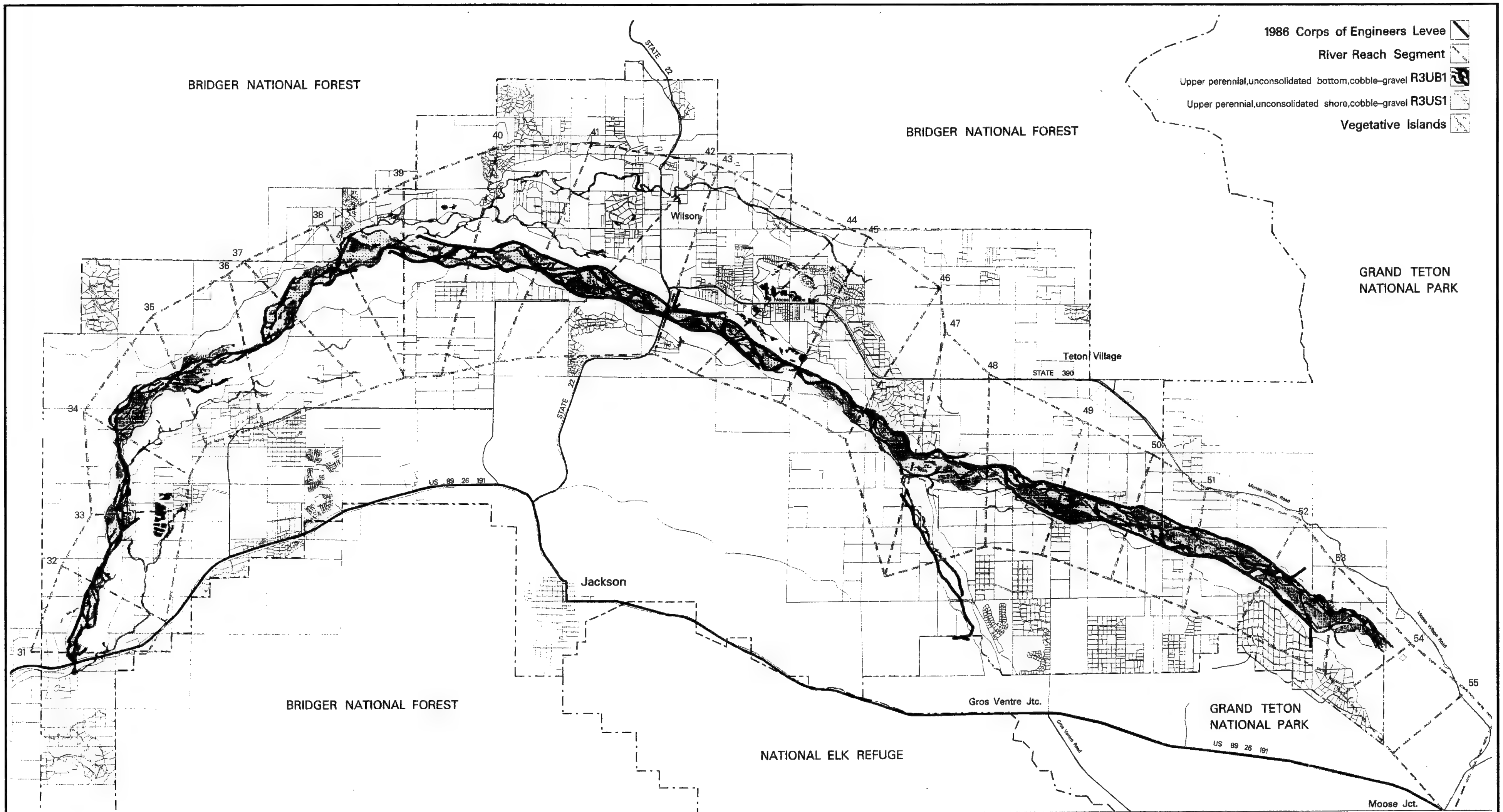


U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

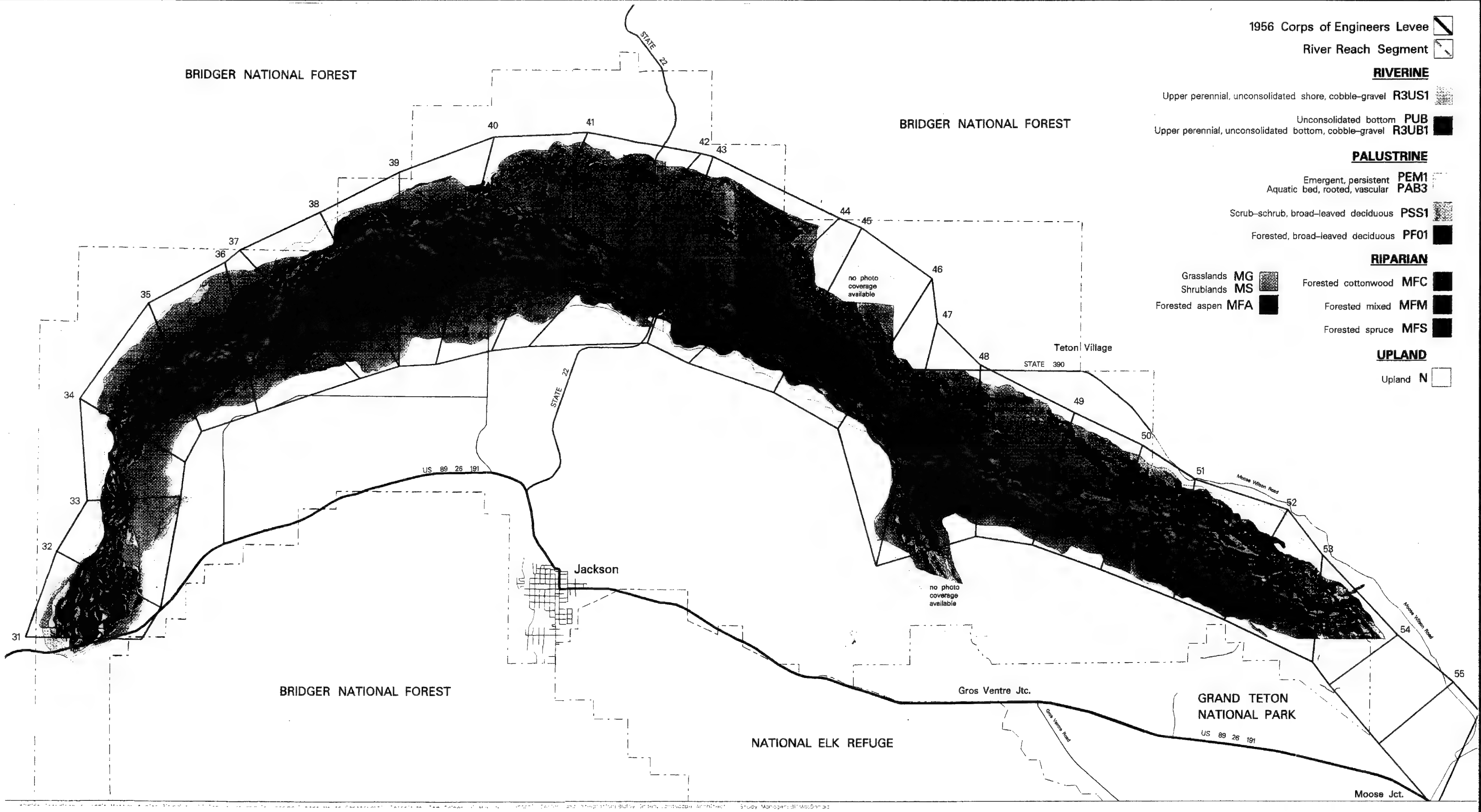
Plate 12:
Snake River Cross Sections, 1956 & 1986



U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 13:
Main Channel Hydrology, 1986

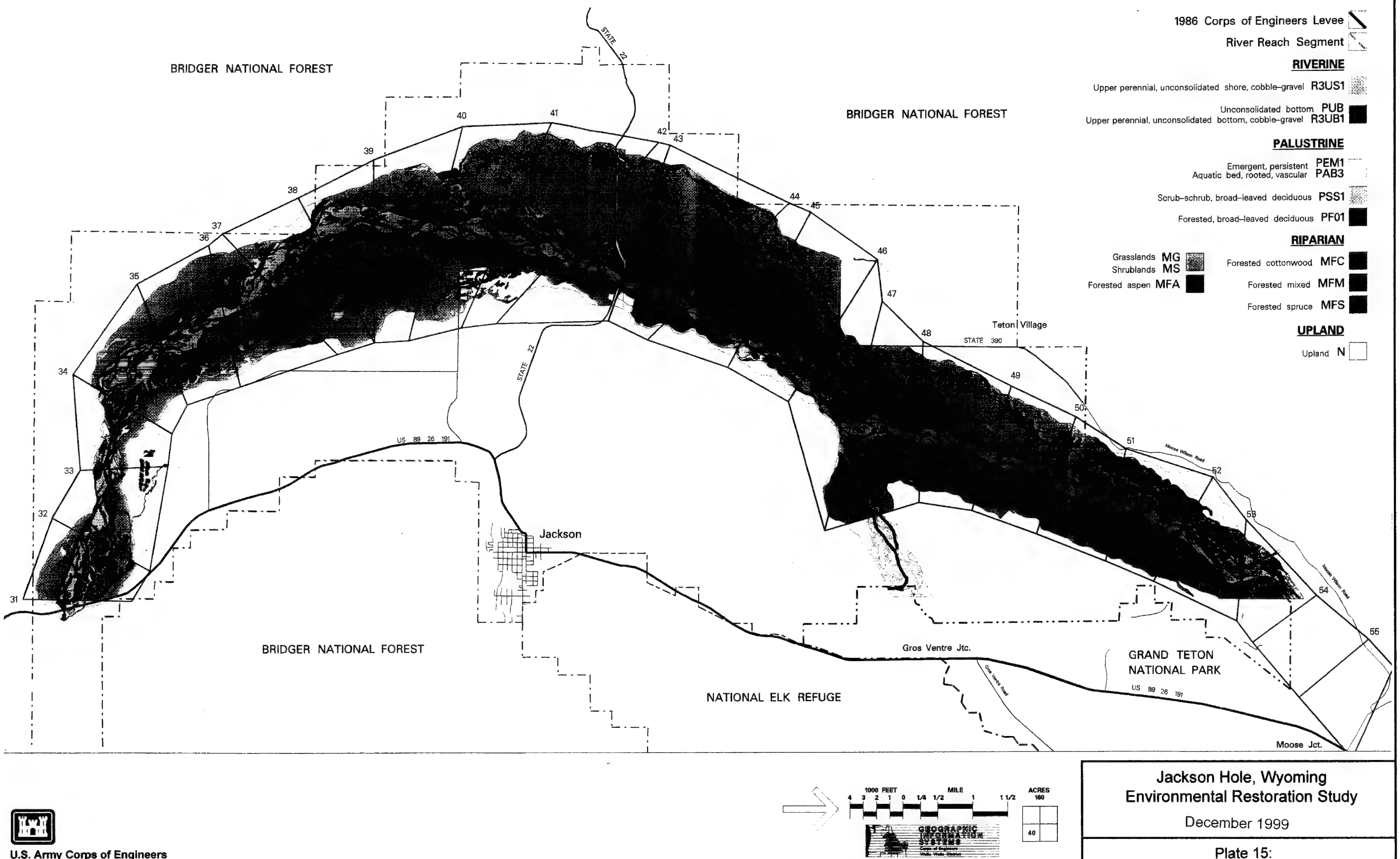


U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

Plate 14:
Vegetation Cover Types, 1956



U.S. Army Corps of Engineers
Walla Walla District

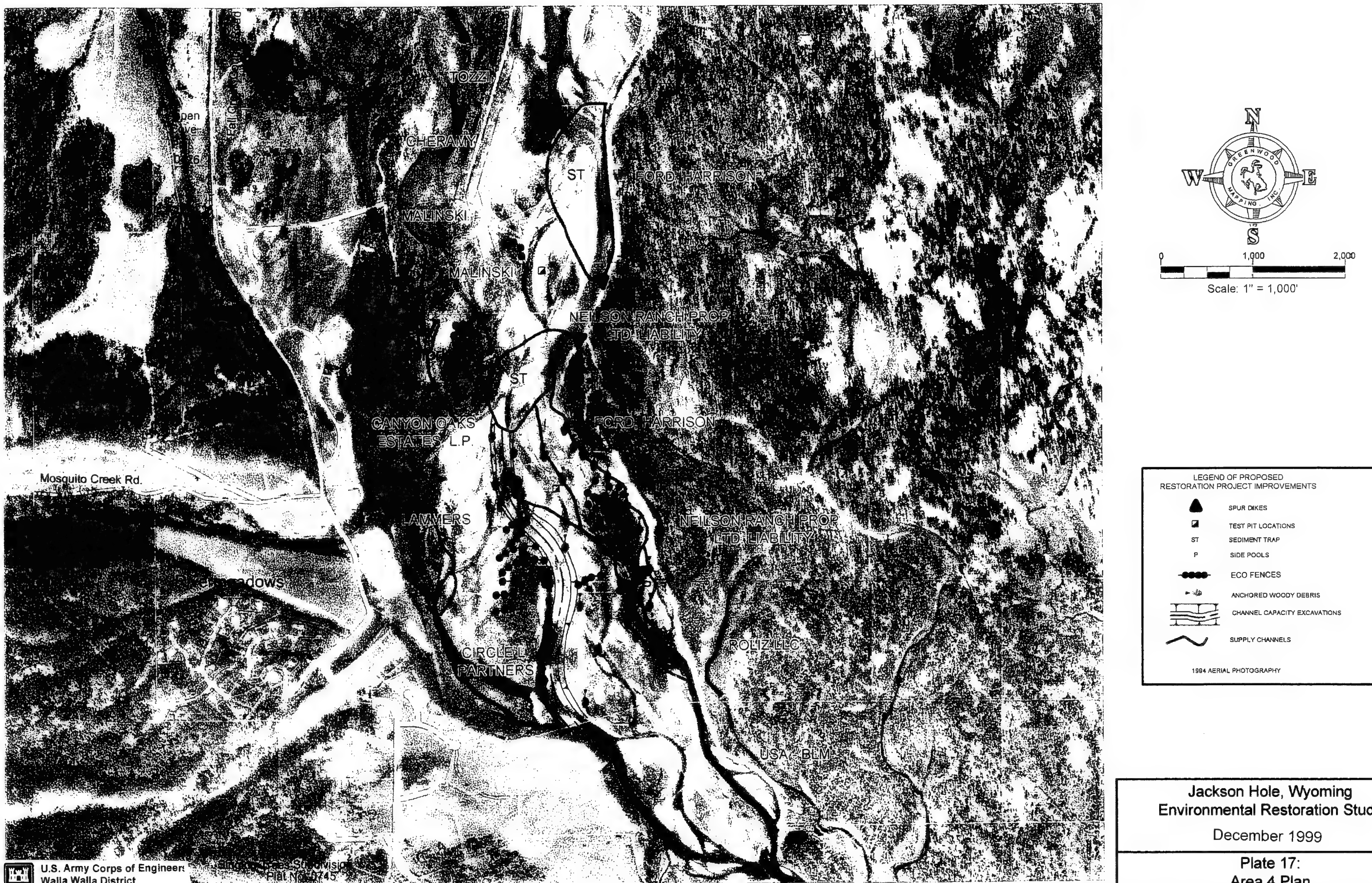
Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 15:
Vegetation Cover Types, 1986

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

Plate 16:
Area 1 Plan

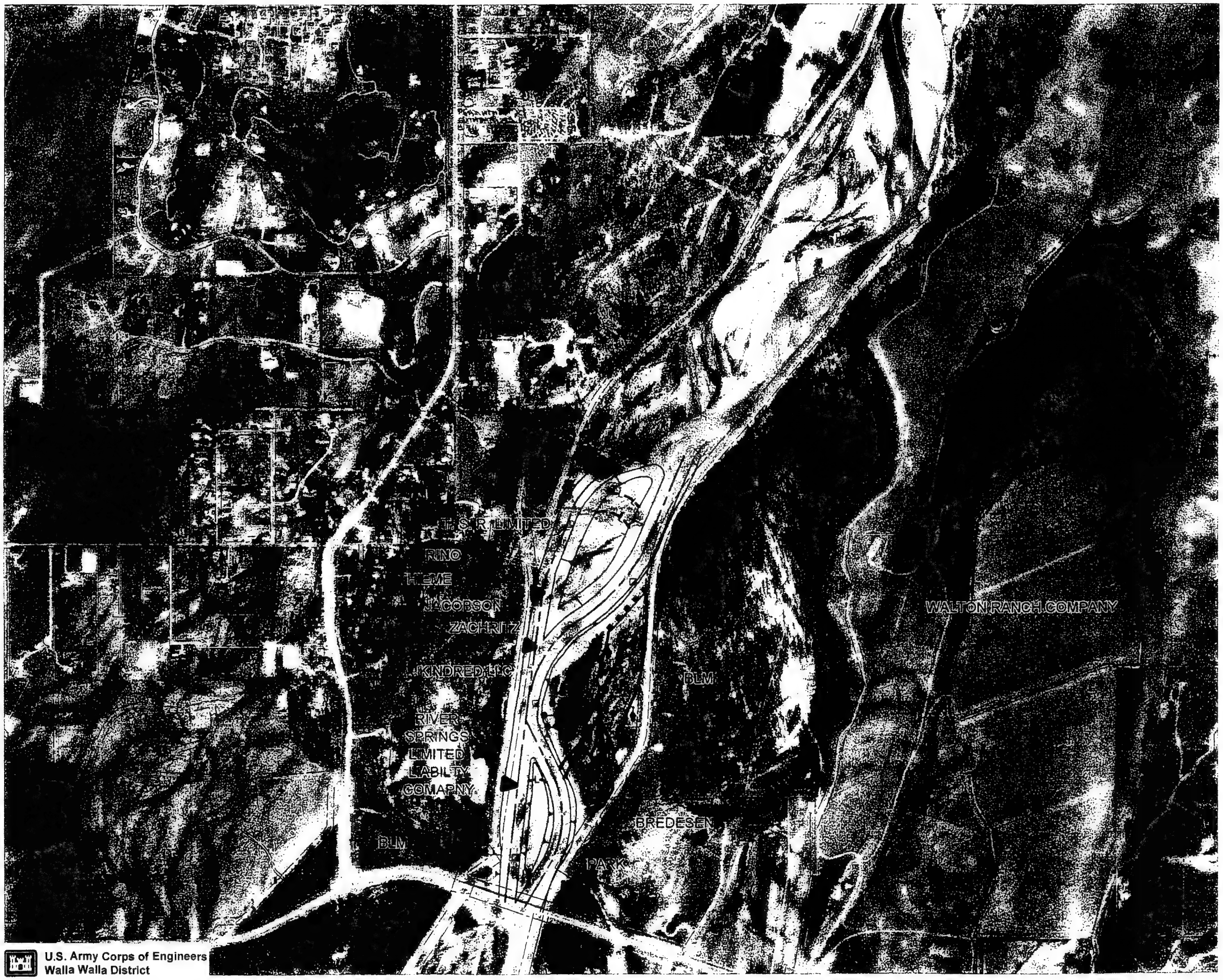


U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

Plate 17:
Area 4 Plan



LEGEND OF PROPOSED RESTORATION PROJECT IMPROVEMENTS

- SPUR DIKES (REPRESENTS 5 SPUR DIKES)
- TEST PIT LOCATION
- P SIDE POOLS
- LOG PLACEMENT
- ECO FENCES
- ANCHORED WOODY DEBRIS
- ROCK GRADE CONTROL
- CHANNEL CAPACITY EXCAVATIONS
- SUPPLY CHANNELS

1994 AERIAL PHOTOGRAPHY

U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study

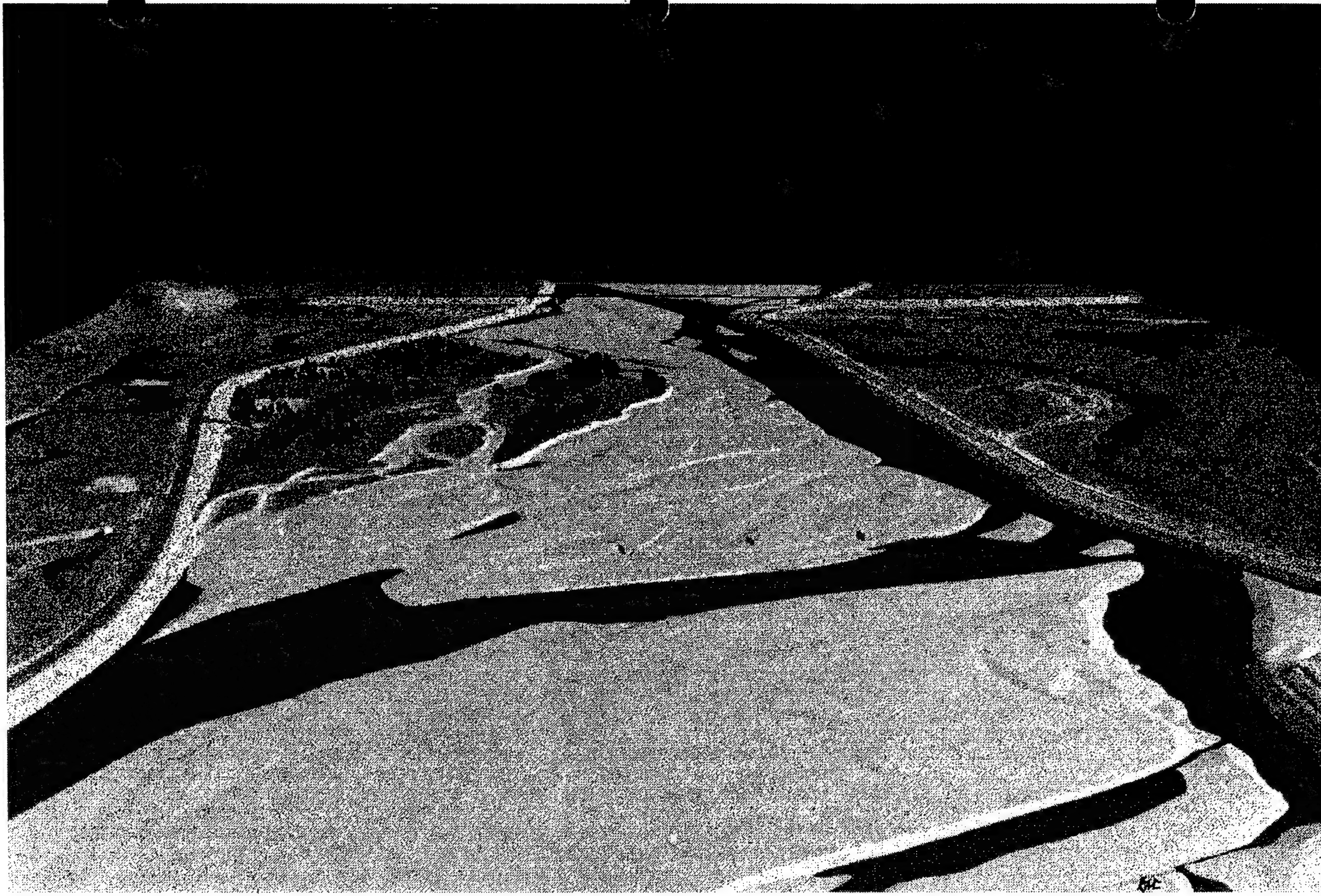
December 1999

Plate 18:
Area 9 Plan

Jackson Hole, Wyoming
Environmental Restoration Study

December 1999

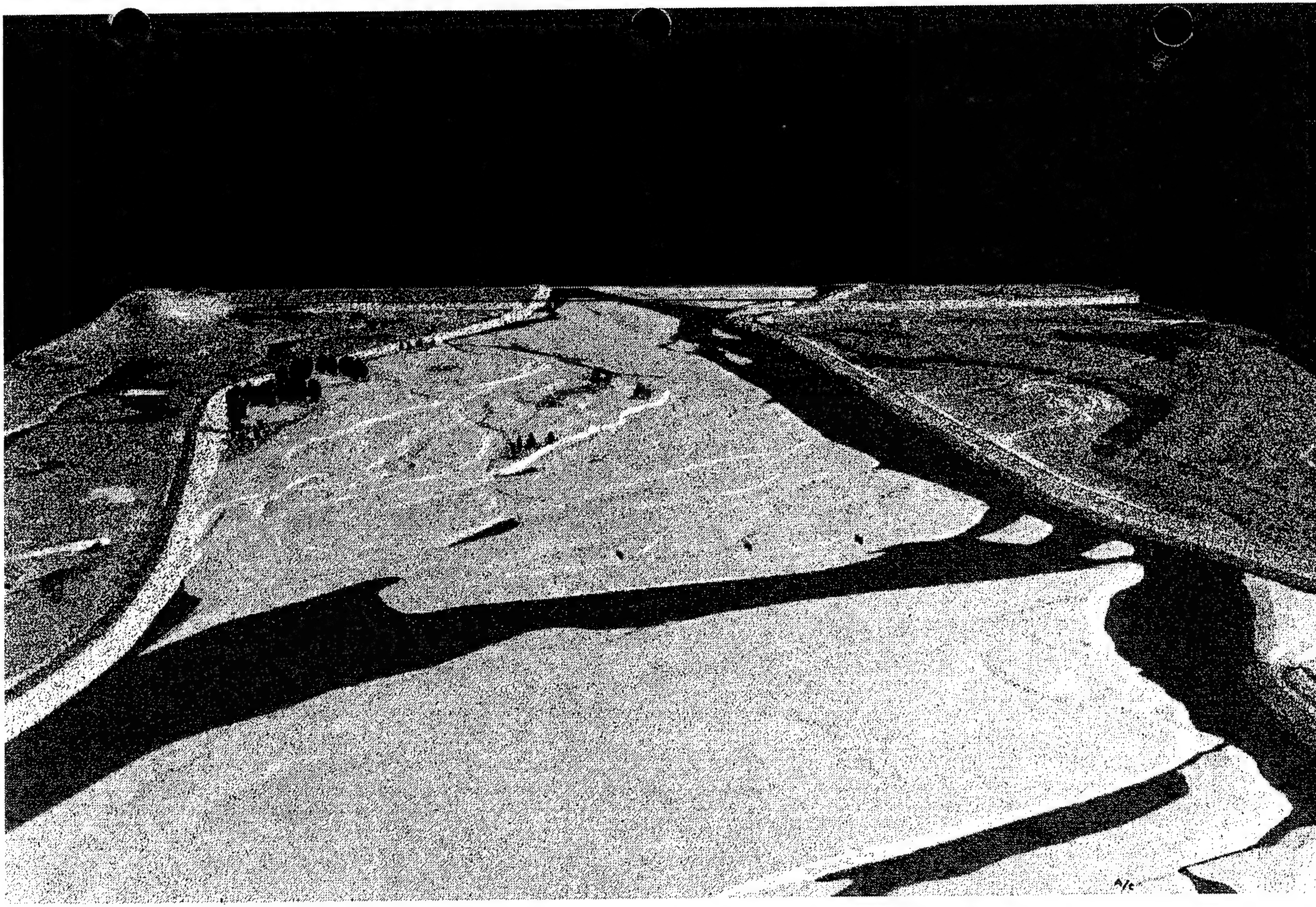
Plate 19:
Area 10 Plan



SITE 9 EXISTING (1996): VIEW LOOKING DOWNSTREAM

U.S. Army Corps of Engineers
Walla Walla District

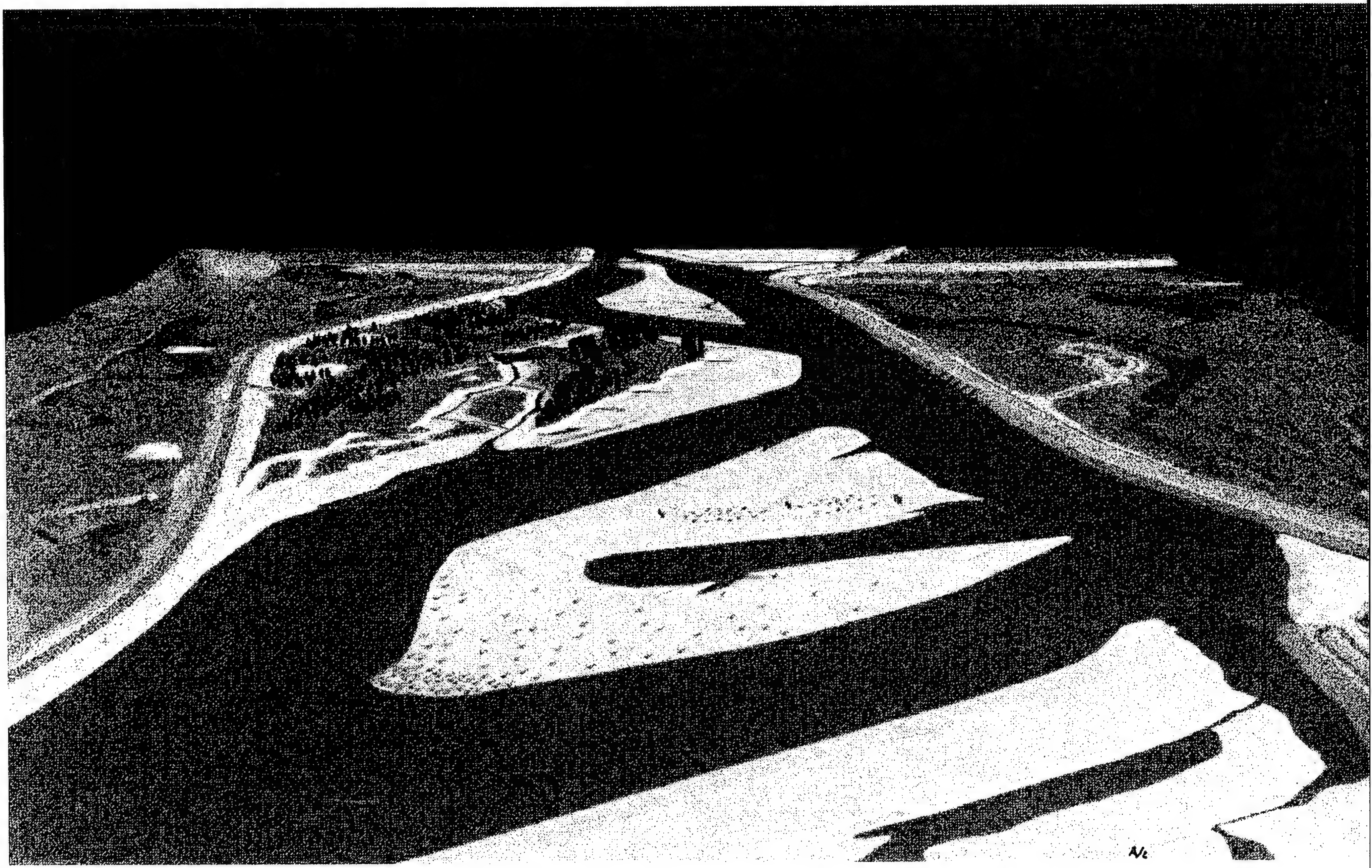
PLATE 20



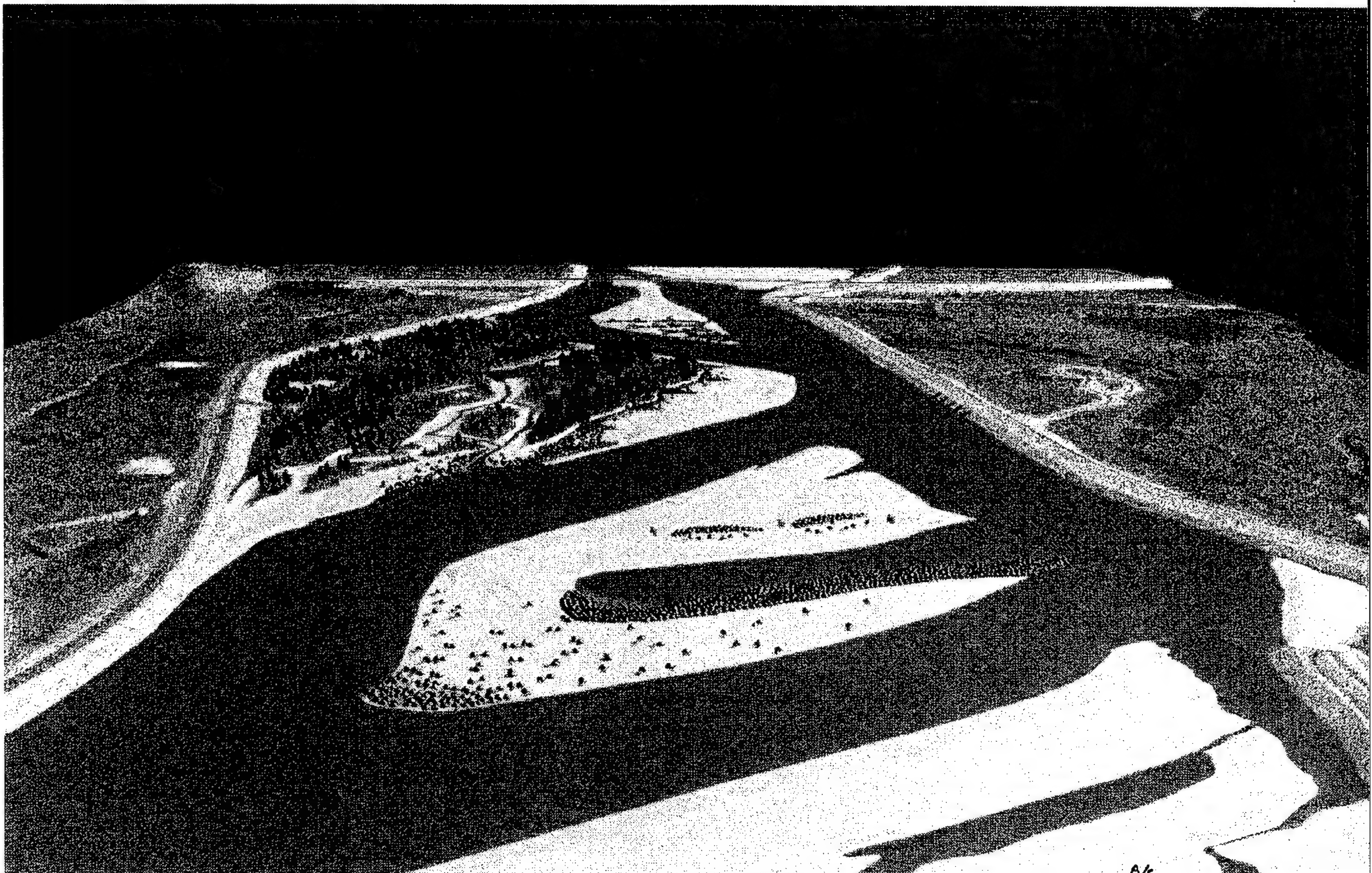
SITE 9 NO ACTION/YEAR 2050: VIEW LOOKING DOWNSTREAM

U.S. Army Corps of Engineers
Walla Walla District

PLATE 21



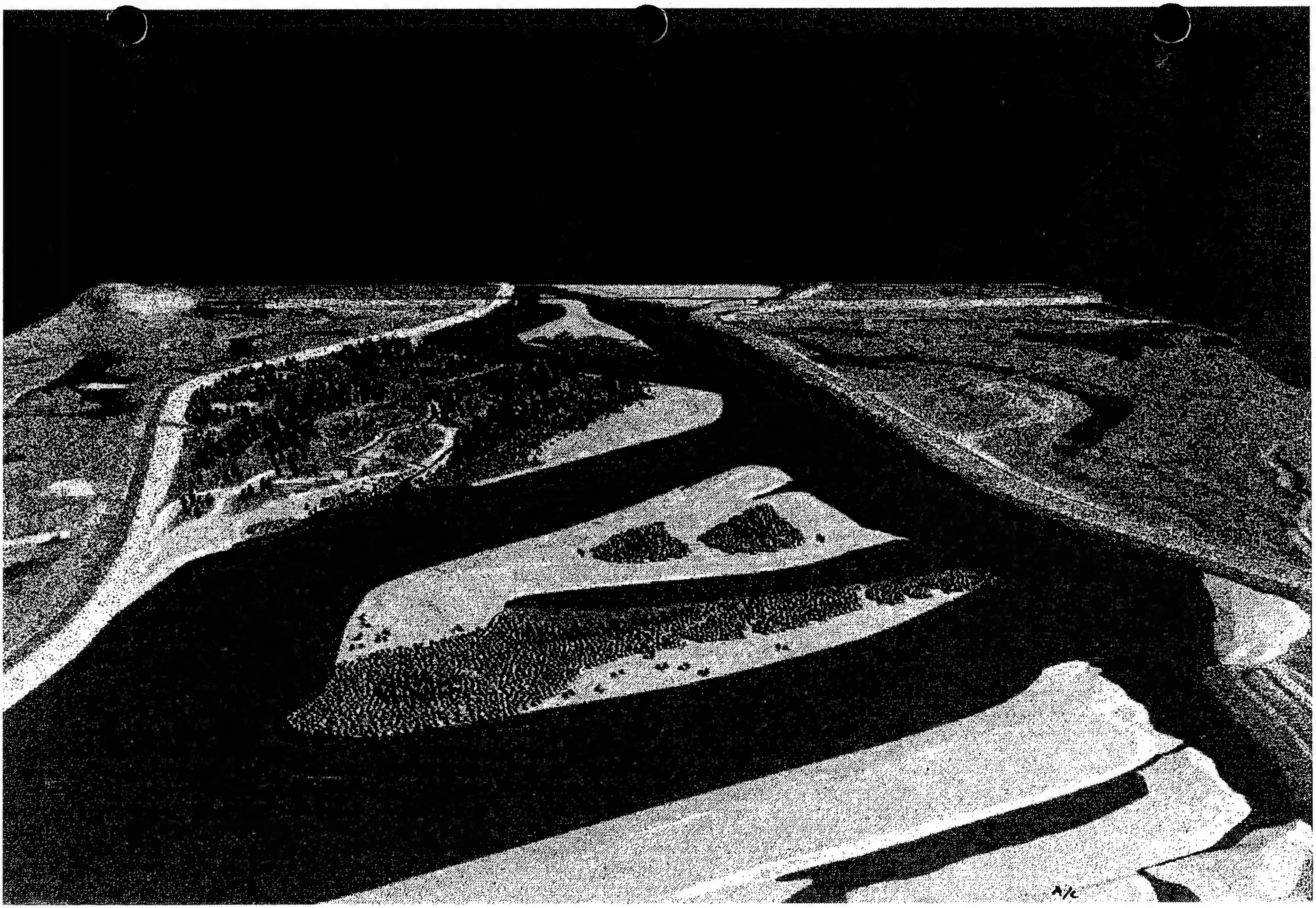
SITE 9 WITH-PROJECT 0-YEAR: VIEW LOOKING DOWNSTREAM



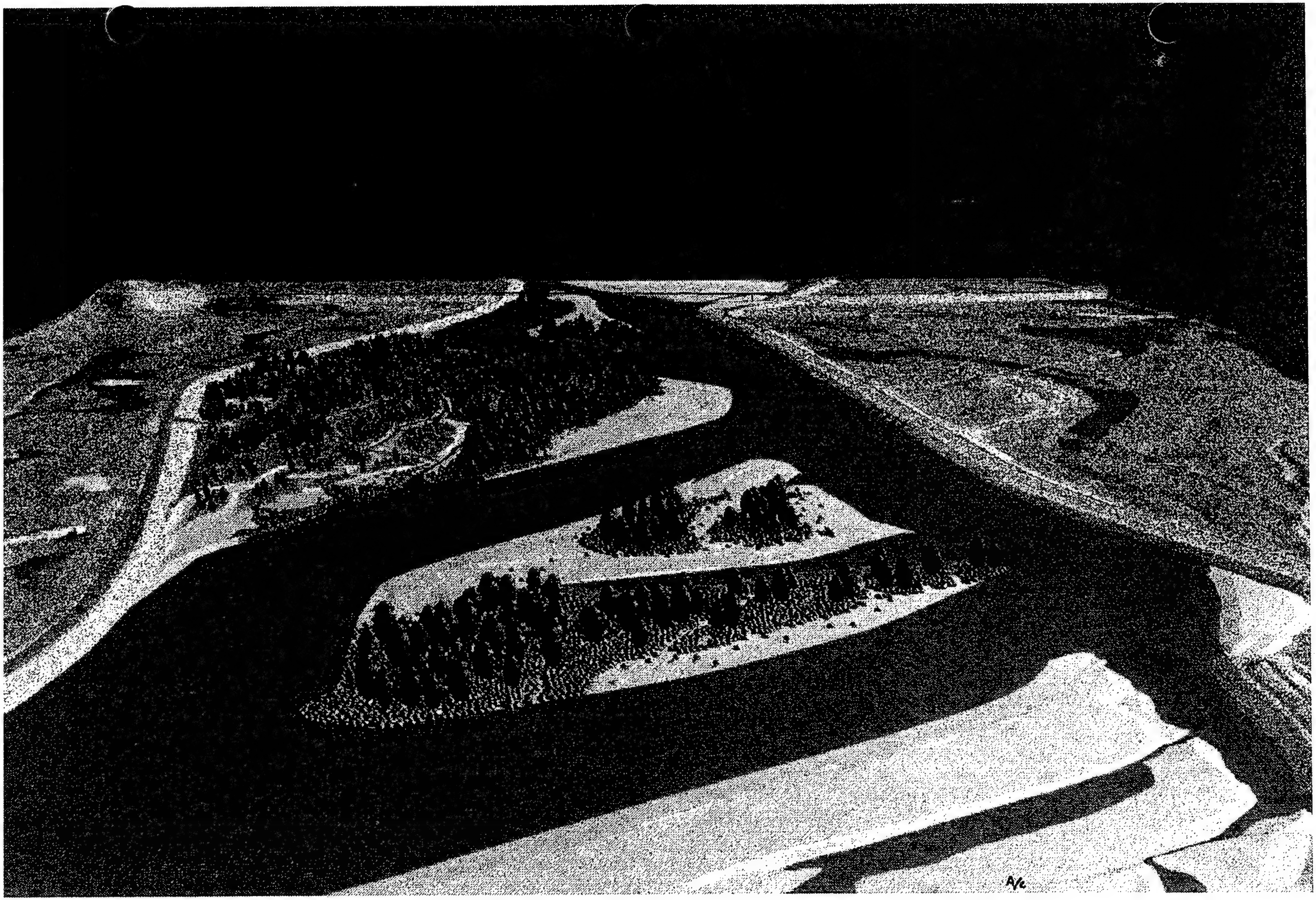
SITE 9 WITH-PROJECT 5-15 YEAR VEGETATION: VIEW LOOKING DOWNSTREAM

U.S. Army Corps of Engineers
Walla Walla District

PLATE 23



SITE 9 WITH-PROJECT 25-YEAR VEGETATION: VIEW LOOKING DOWNSTREAM



SITE 9 WITH-PROJECT 50-YEAR VEGETATION: VIEW LOOKING DOWNSTREAM

U.S. Army Corps of Engineers
Walla Walla District

PLATE 25

Demonstration Project Site 9: Post-construction photo from November, 1998

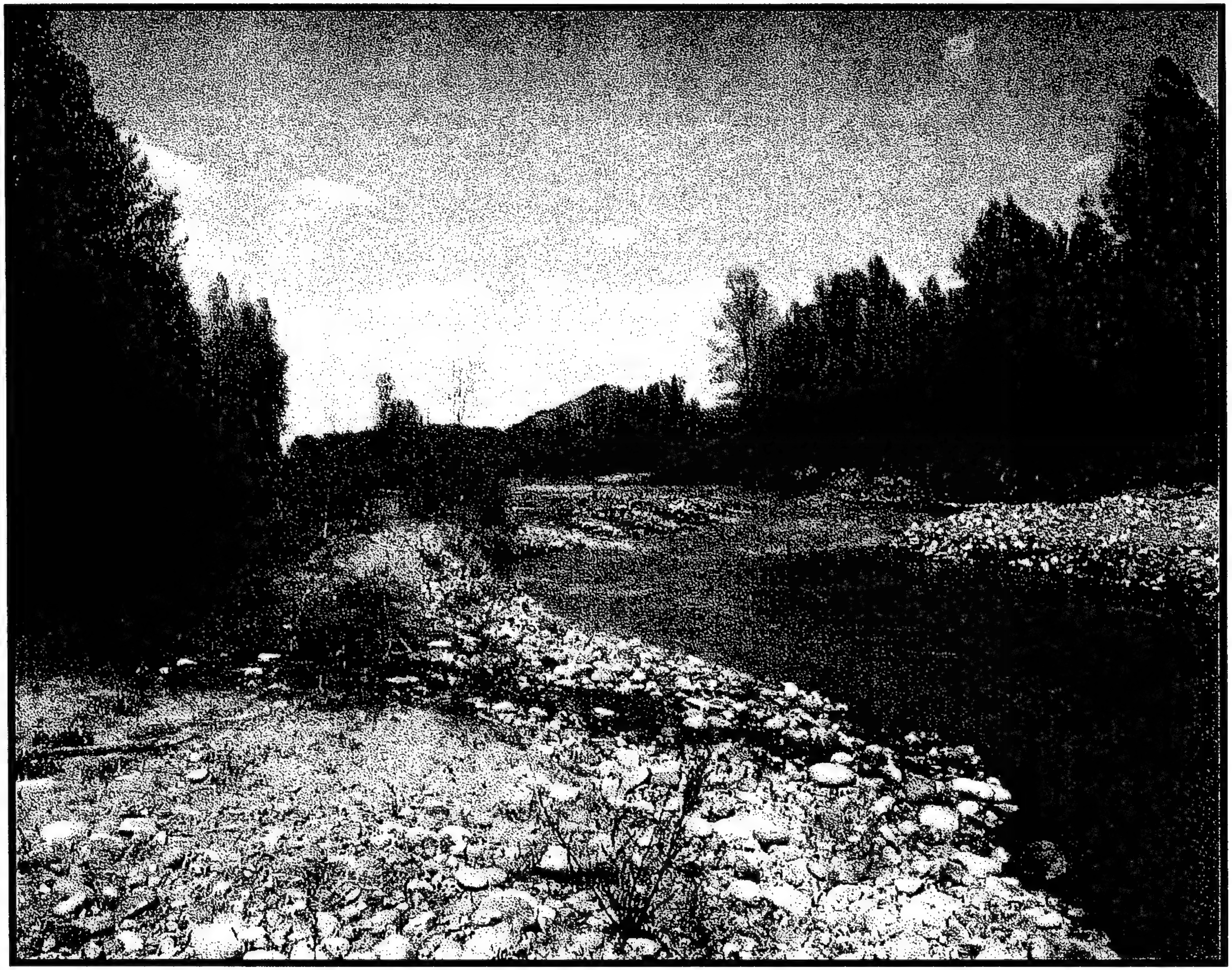
U.S. Army Corps of Engineers
Walla Walla District

Teton County Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 26:
Channel Capacity Excavation



Demonstration Project Site 9: Photo from 27 May, 1999; 14,000 cfs flow

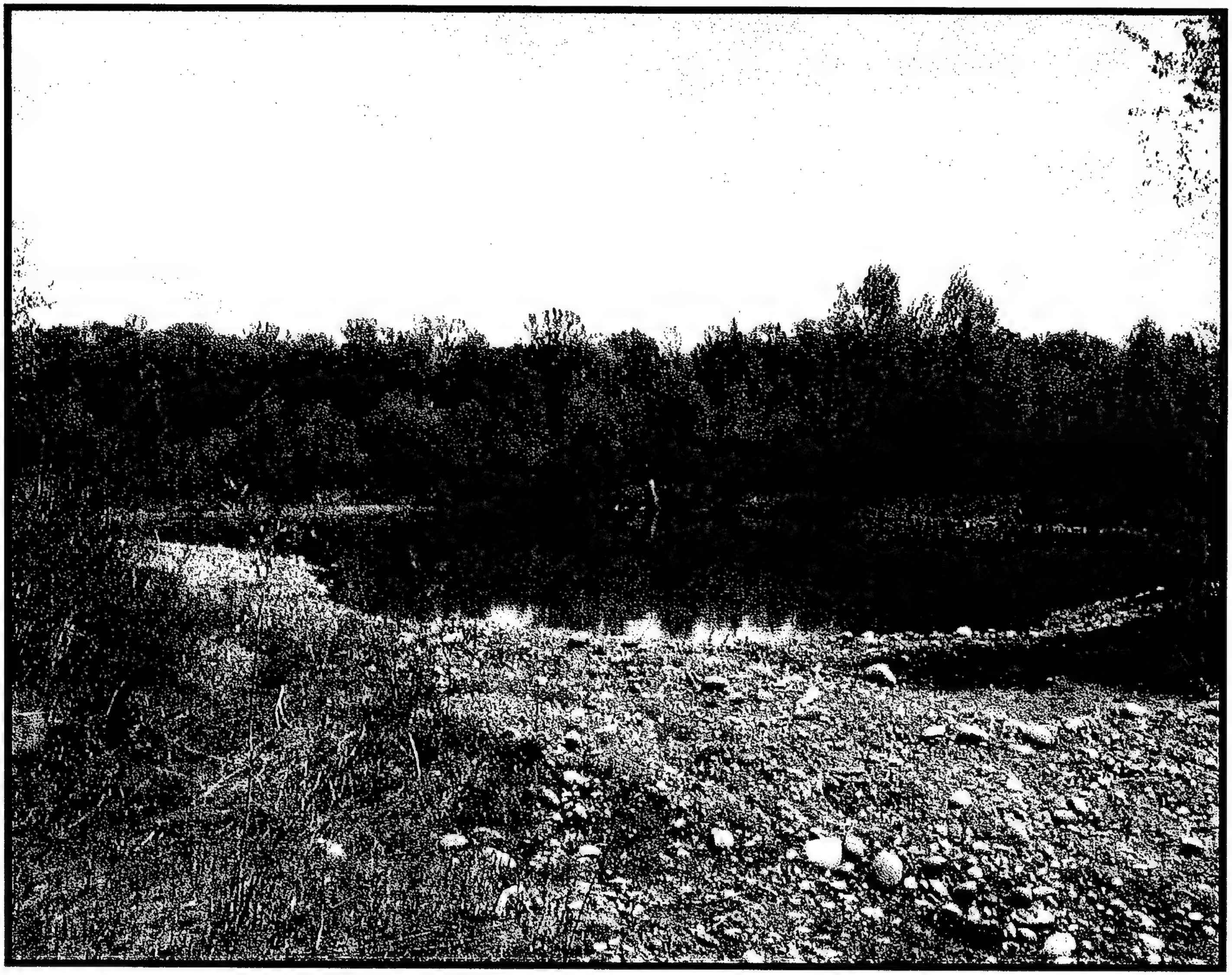
U.S. Army Corps of Engineers
Walla Walla District

Teton County Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 27:
Side Channel Pool



Demonstration Project Site 9: Photo from 27 May, 1999; 14,000 cfs flow

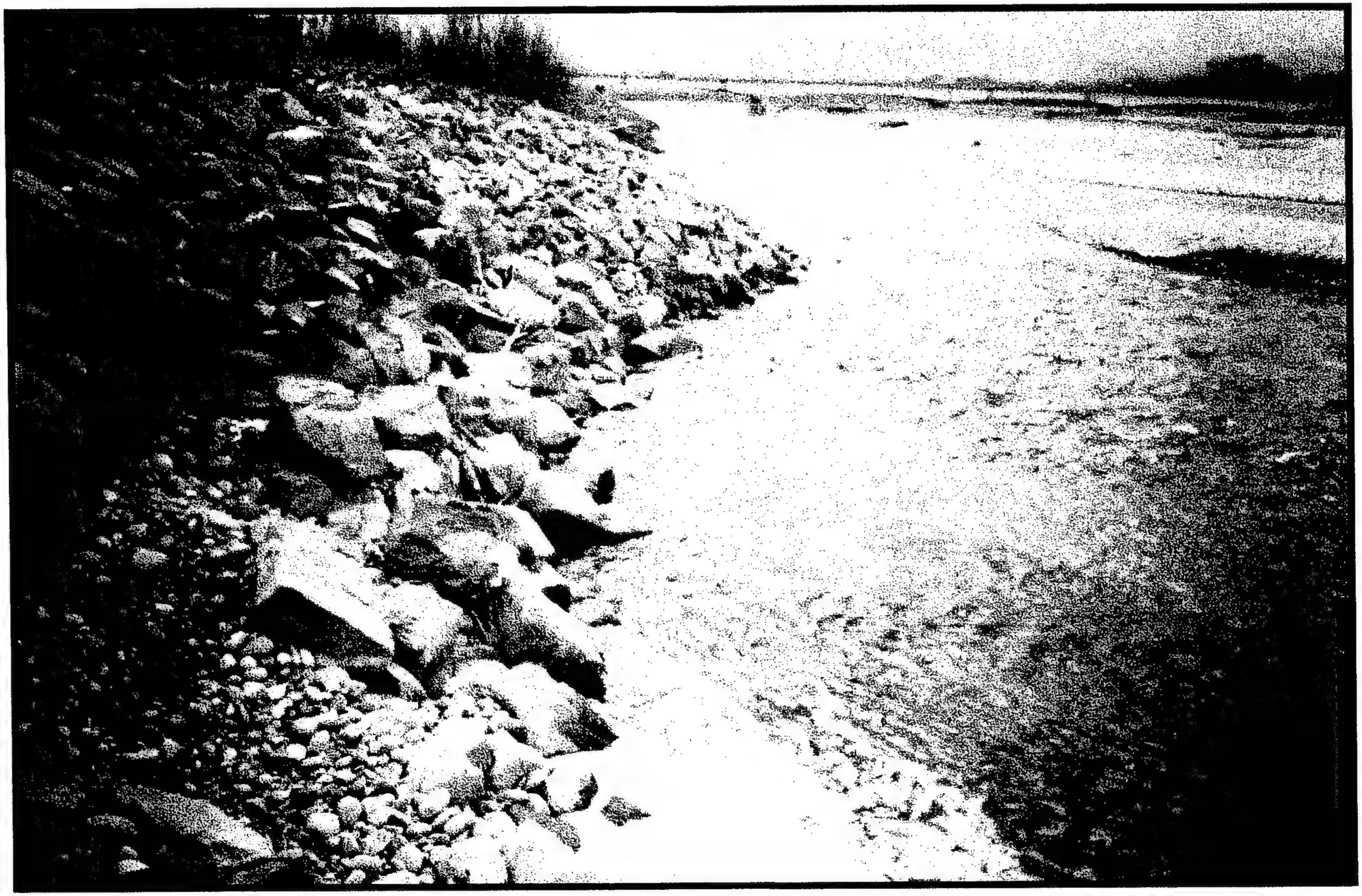
U.S. Army Corps of Engineers
Walla Walla District

Teton County
Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 28:
Off-Channel Pool



Demonstration Project Site 9: Photo from November 1998; 5,000 cfs flow

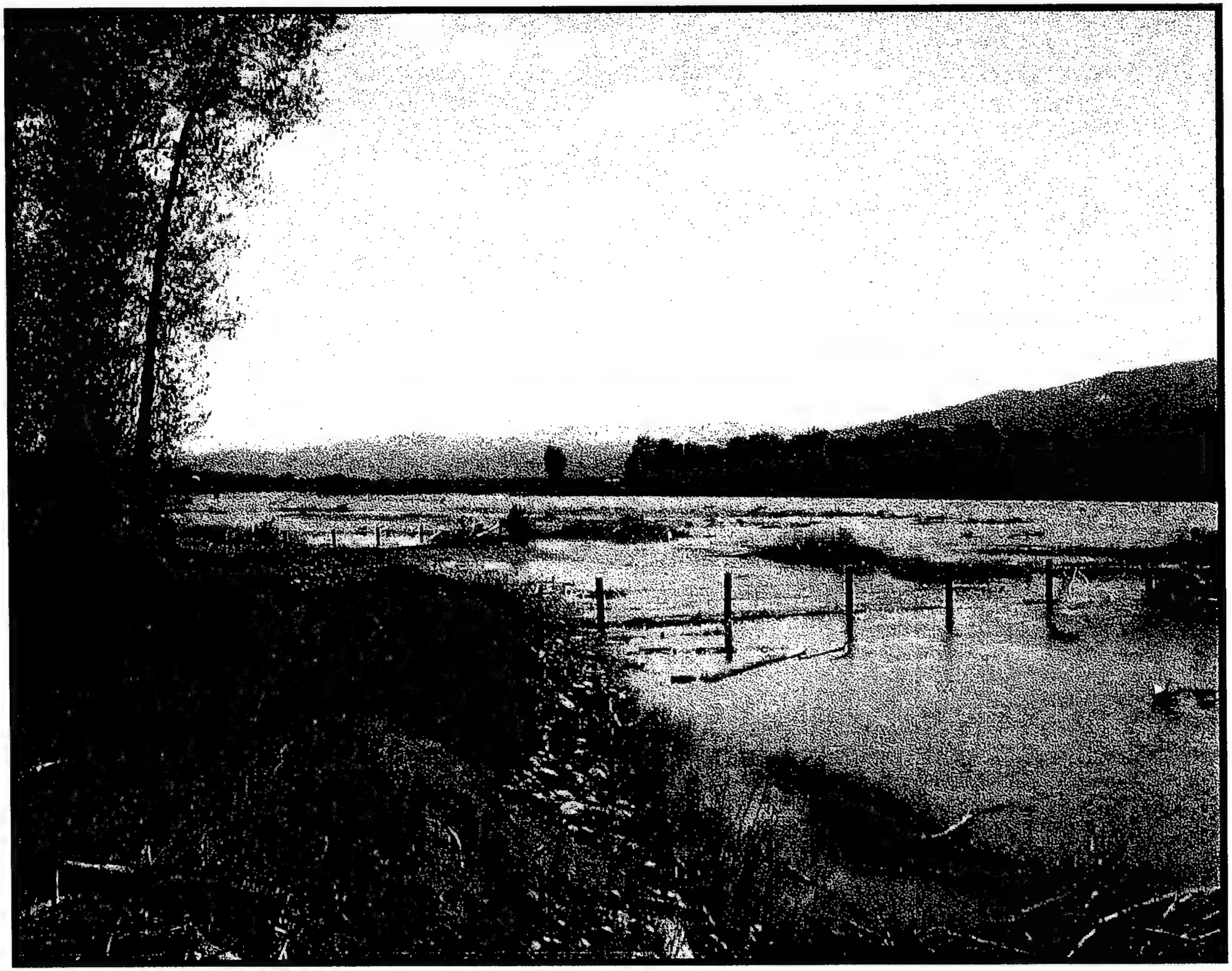
U.S. Army Corps of Engineers
Walla Walla District

Teton County Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 29:
Rock Spur Dike



Demonstration Project Site 9: Photo from 27 May, 1999; 14,000 cfs flow

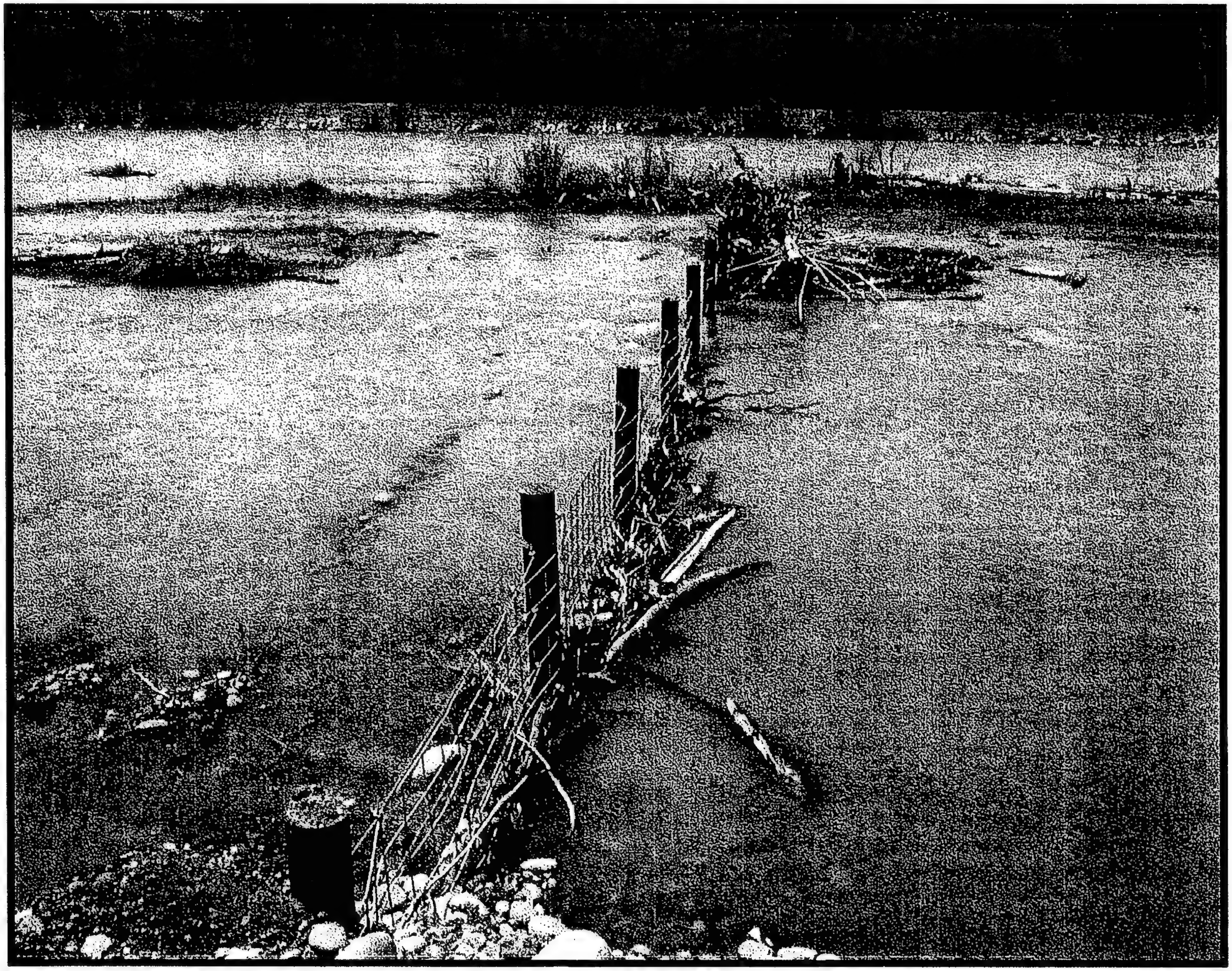
U.S. Army Corps of Engineers
Walla Walla District

Teton County Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 30:
Eco Fence



Demonstration Project Site 9: Photo from 14 June, 1999; 16,000 cfs flow

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 31:
Eco Fence with Debris

U.S. Army Corps of Engineers
Walla Walla District

Teton County
Wyoming

TCNRD

Demonstration Project Site 9: Post-construction photo from November, 1998

U.S. Army Corps of Engineers
Walla Walla District

Teton County Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

Plate 32:
Eco Fence with Large Debris

Demonstration Project Site 9: Post-construction photo from November, 1998

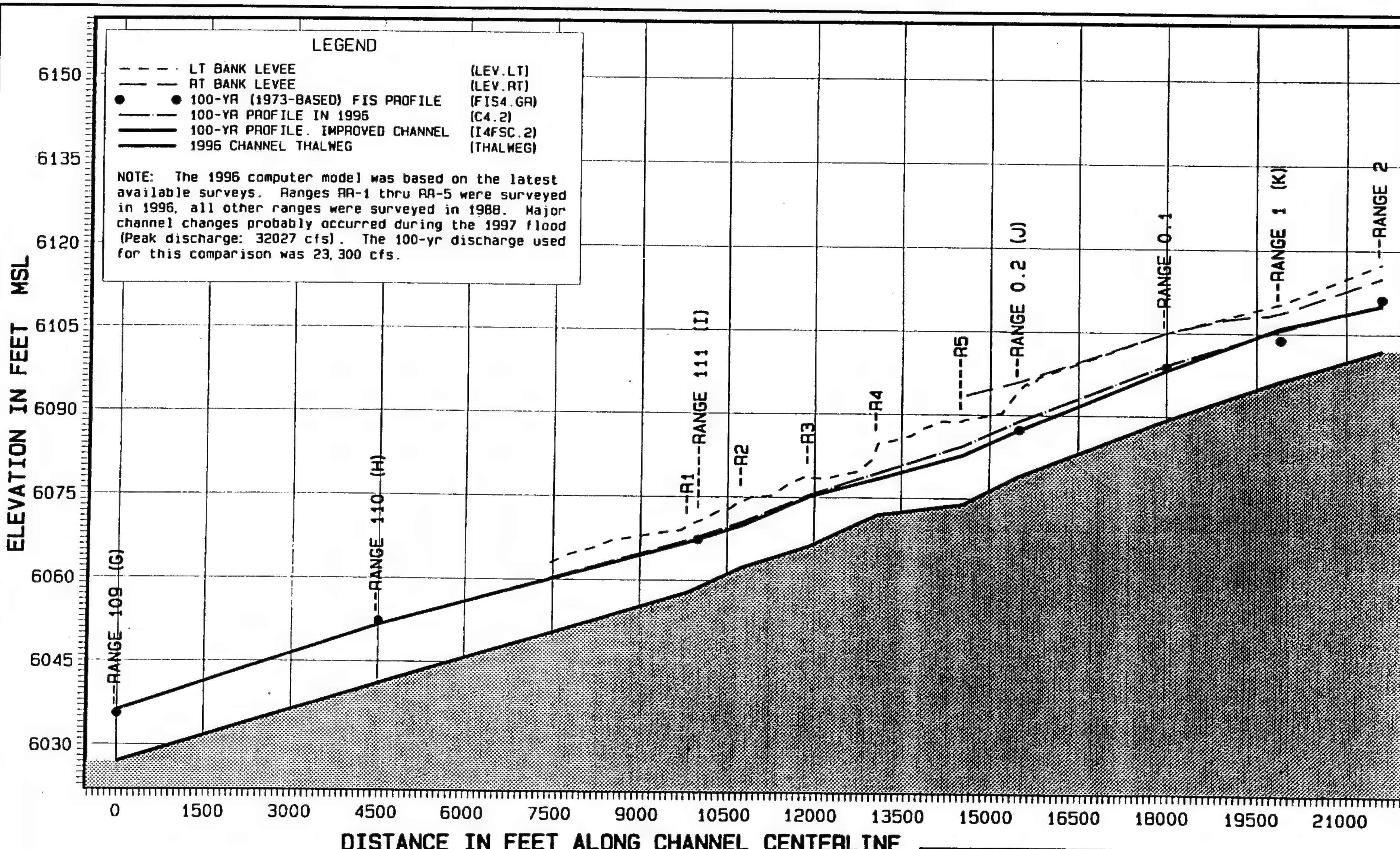
U.S. Army Corps of Engineers
Walla Walla District

Teton County
Wyoming

TCNRD

Jackson Hole, Wyoming
Non-Federal Sponsor Demonstration Project
December 1999

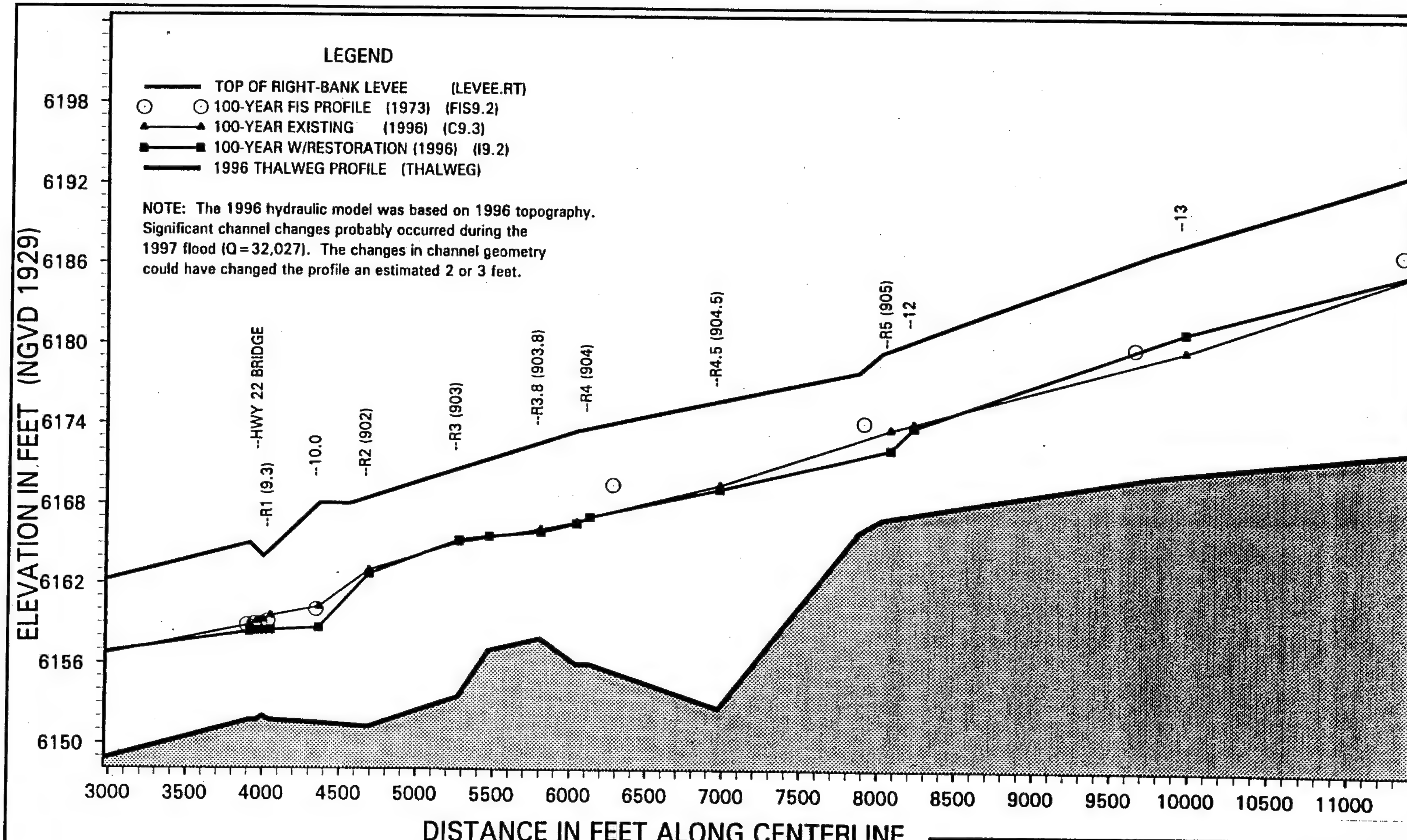
Plate 33:
Rootwad



U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

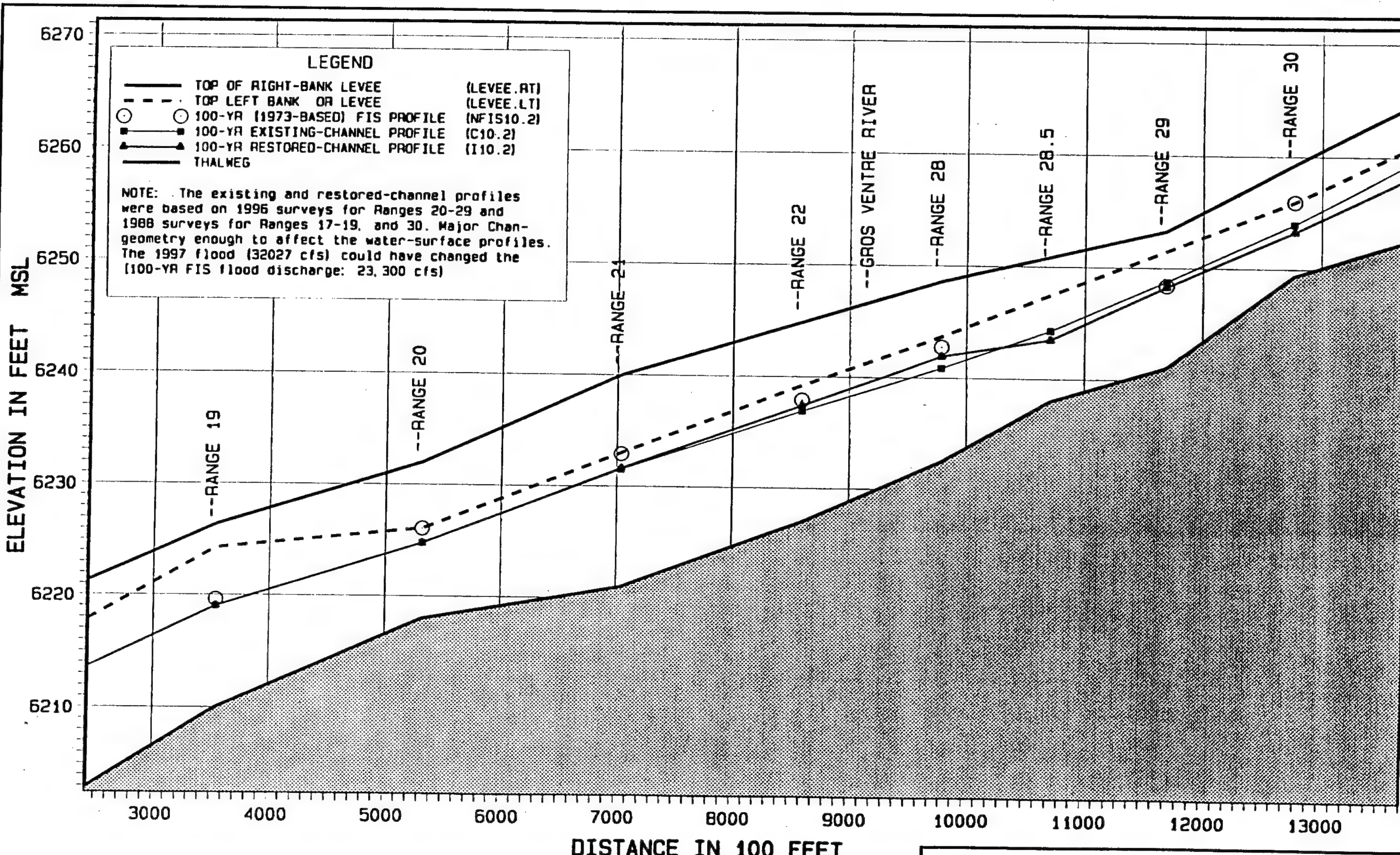
Plate 34:
Area 4: 100-Year Flood Profiles
With and Without Restoration Measures



U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 35:
Area 9: 100-Year Flood Profiles
With and Without Restoration Measures



U.S. Army Corps of Engineers
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Study
December 1999

Plate 36:
Area 10: 100-Year Flood Profiles
With and Without Restoration Measures

APPENDIX H

ENVIRONMENTAL ASSESSMENT

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

NEW NEPA COMPLIANCE INFORMATION

April 2000

The attached Environmental Assessment and Draft Finding of No Significant Impact (FONSI) were prepared in the spring of 1999. The preferred plan (referred to in the draft Feasibility Study as the "Initially Proposed NER Plan") at that time addressed various construction tools to be used in the selected four sites (Areas 1, 4, 9 and 10). At that time, the proposed project covered approximately 5 miles of the 22-mile reach of the river that is bounded intermittently by Federal flood control levees. Subsequent to that evaluation, a decision was made to expand the area of the proposed project to encompass the entire 22-mile reach. The project expansion resulted from discussions during an Alternative Formulation Briefing and a site visit with Corps of Engineers, Headquarters personnel, in October 1999.

Walla Walla District received a recommendation to consider using the cost and benefit information gathered for the 5-mile study area (presented in the report as the "Initial Plan") as a proxy for the entire 22-mile reach. The rationale is that the engineering measures that would be used had already been identified, the benefits of the management measures had been measured, and the construction costs had been developed. The District could use the site-specific information to formulate a complete plan to restore the entire degraded area. The complete plan developed by the District is presented as the "Progressive Plan" in the draft Feasibility Study.

The proposed environmental restoration project is expected to be of increasing benefit as additional sites are approved, funded, and constructed. The project's objectives are enhanced by the proposal to include additional sites. The specific objectives of the project are to restore river channel stability, protect the remaining diverse habitats, restore diversity and sustainability to degraded habitats, and restore degraded habitats for threatened and endangered species.

The attached Environmental Assessment was centered on the evaluation of the tools and methods of construction. These same tools will be utilized in additional sites selected for construction in the project area. Since this project is designed with an adaptive management component, the type of tools used at each subsequent site will be greatly influenced by the success of the tools implemented in the first four sites. Monitoring is an important aspect of this project, and results will be incorporated into future site development.

The final FONSI will address the sites for which detailed evaluation and coordination is complete and also the process and schedule for any additional site-specific documentation and coordination determined necessary. The current NEPA documentation is sufficient to begin project construction of the first 4 sites, as each of the 12 sites has independent utility and are not interdependent. Any additional site-specific documentation or coordination needed on one or more of the eight additional sites is to be completed nearer time of scheduled implementation or construction, as part of the adaptive management strategy of this project.

DRAFT

FINDING OF NO SIGNIFICANT IMPACT

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION

The U.S. Army Corps of Engineers (Corps), Walla Walla District, proposes to construct channel stabilization pools, off-channel pools, secondary channels, eco fences, spur dikes, rock grade control structures, place root wad logs, and remove gravel for environmental restoration in the Snake River at Jackson, Wyoming. The purpose of the project is to restore fish and wildlife habitat that was lost as a result of the construction, operation, and maintenance of levees constructed under the Jackson Hole Flood Control Project (Public Law 516, Flood Control Act of 1950), including levees constructed by non-Federal interests (Water Resources Development Act of 1986).

The U.S. Senate Committee on Environment and Public Works authorized in a Study Resolution of June 12, 1990, the Jackson Hole, River and Wetland Restoration Study, Wyoming, to determine the advisability of restoring fish and wildlife habitat. The levees reduced the available floodplain resulting in increased water velocities, unstable channel configurations, elimination of natural channel braiding, and erosion of islands and associated vegetation. Snake River fine-spotted cutthroat trout have been and continue to be affected by the loss of spawning areas and in-stream and over-wintering habitat. Spawning areas in the main river are reduced through scouring and in spring creeks due to debris blockages. Other habitat impacts for fish include the loss of shade, in-stream woody debris, and low-energy resting habitat. Terrestrial habitat has also been affected through the loss of shrub-willow and cottonwood riparian areas typically used by moose, elk, mule deer, furbearers, numerous small mammals, and various other wildlife species.

The Corps prepared an Environmental Assessment (EA) to evaluate the potential effects of restoration measures upon environmental resources and upon the Jackson Hole Flood Control Project. The purpose of the EA is to ensure actions and restoration measures proposed as a result of the study meet the requirements of the National Environmental Policy Act of 1969 and subsequent implementing regulations issued by the Council on Environmental Quality (40 CFR 15000) and the Corps' ER 200-2-2.

The Corps evaluated 4 alternatives in the EA, including the "no action" alternative. Alternative 1 included the comprehensive implementation of restoration measures throughout the 500-year floodplain at an unlimited number of areas. This broad approach to restoring aquatic and terrestrial habitat would implement measures between the levees, restore flows to spring creeks and vegetation outside of the levees, as well as maintain the base flood capacity. This comprehensive approach satisfied the purpose and need of the project. However, it proved to be

too comprehensive and, therefore, too costly for the local sponsor and was thus eliminated from further consideration.

A second alternative was developed to provide a similar comprehensive approach to restoring aquatic and terrestrial habitat and maintaining base flood capacity inside the existing levee system. Under this alternative, twelve specific areas were identified for implementation of restoration measures. This alternative satisfied the project purpose and need, but exceeded the local sponsor's fiscal capability. This alternative was also eliminated from further consideration.

A third alternative involved reducing the 12 specific sites to 4 specific sites that would have the greatest potential for restoring lost aquatic and terrestrial habitat and maintaining base flood capacity. To arrive at the four sites, the Corps conducted a multiple objective analysis. The analysis evaluated the areas on a number of elements including institutional recognition (national laws and regulations specific to the area), public recognition (environmental and economic value), and technical recognition (importance of spring creeks, spawning habitat, and eagle nesting). Additional analysis included the potential for channel creation for fisheries restoration, riparian island preservation and restoration, fish habitat creation, and spring creek restoration. It also included specific input from the scoping process, local input, and considerations of property ownership and cultural resources. The 4 sites selected were areas 1, 4, 9, and 10. This alternative satisfied the project purpose and need and was determined to be within the local sponsor's fiscal capability. Because this alternative would satisfy the project purpose and need and be within the local sponsor's fiscal ability, the Corps selected it as the preferred alternative.

Under the "no action" alternative, Alternative 4, the progressive loss of portions of the remaining aquatic and terrestrial habitat between the levees would continue. The Corps determined the "no action" alternative would not meet the purpose of the project or satisfy the need to prevent further loss of aquatic and terrestrial habitat and restore portions of habitat already lost. Although the "no action" alternative was not selected as the preferred alternative, the "no action" alternative would, by default, become the preferred alternative should the project not proceed to the construction phase.

The EA, along with appendices, which included a Biological Assessment, Coordination Act Report, Cultural Resource Evaluation and Section 404(b)(1) Evaluation, was distributed for public review during the period March 5 through April 6, 1999. The Corps received and responded to 7 comment letters. The comments were incorporated into our findings as a supplement to the EA and included in our evaluation. Those comments incorporated as additions to or modifications of the EA are noted in the attached Comment Response Package.

I have taken into consideration the technical aspects of the project, best scientific information available, public comment, and determinations of the EA. Based on this information, I have determined that the proposed action would not significantly affect the quality of the human environment, and that an Environmental Impact Statement is not required.

DATE: ________________

____
William E. Bulen, Jr.
Lieutenant Colonel, Corps of Engineers,
District Engineer

DRAFT

JACKSON HOLE, WYOMING
ENVIRONMENTAL RESTORATION PROJECT

COMMENT RESPONSE PACKAGE

DATE

JACKSON HOLE CONSERVATION ALLIANCE

3/29/99

ATTN: James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith,

I am writing on behalf of the Board of Directors and over 1,600 members of the Jackson Hole Conservation Alliance (JHCA) in regards to the Jackson Hole, Wyoming Environmental Restoration Project Environmental Assessment (EA). We are intrigued by the proposal and think that the concept for an aquatic and habitat restoration project within the Snake River Levee system is a good idea. Having worked with the Army Corps of Engineers for years to try to gain public acceptance for restoration activities, JHCA recognizes the potential benefits of this project. However, in reading through the EA, in some cases we were left wondering whether the ends justified the means. Therefore, while we support the overriding goal of the Snake River Environmental Restoration Project, we hope that some of the details can be amended as to minimize intrusion into the river and maximize positive results.

1 1. The Corps must take full responsibility for monitoring the pilot project currently in operation before it finalizes and undertakes the proposed project. What is being done to document the successes and failures of the pilot project? From our perspective, it is important to know what aspect of the pilot project are working and which ones are not working in order to produce the most effective restorative capabilities of the four sites proposed for restoration activities. Any problems identified through the monitoring activities should be addressed with proposed solutions.

2 2. We would like to see an accurate timeline describing when there would be scheduled work activity in the project areas. The EA is unclear in describing the work schedules for each project area and JHCA would like to see those concerns addressed to ensure that the needs for wildlife migration and threatened and endangered species are considered in the work plan.

3 3. As outlined, we are concerned about the gravel removal process from the project area. Can we get some assurances that the gravel removal process associated with this proposal will be driven by the river itself and not the gravel needs of the excavator? Having driven over the Wilson bridge all winter, the site of the pilot project, it appeared that gravel trucks were in the river an excessively long time. Is there any analysis of impacts (scenic, social, wildlife, and other) of a back hoe removing substantial amounts of gravel in the river for an extended period of time?

4 4. In the "Project Purpose and Need" section of the Environmental Assessment, the Corps states, "The project has high potential for restoring fish and wildlife habitat through enhancement and restoration of the aquatic and terrestrial environment, including wetland and riparian vegetation and in-stream fisheries habitat." Is there

P.O. Box 2728 Jackson, WY 83001 (307) 733-9417 FAX (307) 733-9008 E-mail: jhca@wyoming.com Web page: http://www.jhalliance.com

any proof or any documentation of other projects that have undertaken similar activities and been successful? JHCA feels that the Corps needs to make sure that this prediction comes true through the current pilot project before undertaking the remaining projects so there is opportunity to make adjustments based on the success or failure of the pilot.

5 5. We are also concerned about the various access points for each of the project areas. Is there a map outlining where these access points will occur and possible impacts upon vegetation and wildlife?

6 6. What safety issues are there pertaining to eco-fences? Will there be a safety issue for boaters and fisherman wading in the river near eco-fences? How are these areas going to be marked so recreationist can identify them?

All and all, JHCA supports this project and the projected goals for restoring habitat in the area impacted by the Snake River Levees. We just want to make sure that this project does not do more damage in its efforts to reverse past damage. We think that the chance of this could be minimized by applying lessons from the pilot project to the additional project areas proposed for restoration activities.

Sincerely,

Mac Munro
Issues Assistant

Pam Lichtman
Program Director

Response to March 29, 1999 letter from Jackson Hole Conservation Alliance

Comment 1 – Teton County undertook the demonstration or pilot project separate from the Jackson Hole, Wyoming Environmental Restoration Project Feasibility Study which they co-sponsor with the Corps. The Corps' funding authorizations do not include implementation or monitoring of the demonstration project. Assessment of the demonstration project's effects upon fisheries, water quality, vegetation, and physical changes in topography would be conducted or coordinated by Teton County. The extent of monitoring, including selected items, methods, and duration will be limited to those requirements established under Teton County's Clean Water Act, Section 404 Permit and any other parameters which Teton County may choose to monitor. Any results of their monitoring and assessments would be provided to the Corps for consideration during subsequent planning, engineering, and designing of restoration tools for the 4 restoration sites. See response to April 9, 1999 letter from Wyoming Game and Fish Department, Comment 5.

Comment 2 – Multiple factors relating to water flows and activities of particular wildlife species would restrict the timeline or schedule. These restrictions are addressed throughout the text of the Environmental Assessment (EA) as well as in the Biological Assessment (BA), Appendix A to the EA. Construction activity would principally be limited to periods of low river flows. The low flow period will vary based on seasonal influences. Most work would be expected to occur during the period August 15 through November 15, however, the period could be shorter or longer. Other influences which may further restrict scheduling include factors related to the presence of migratory big game, avian nesting activity, and activities of endangered species such as the bald eagle, peregrine falcon, whooping crane, grizzly bear and gray wolf. Because of these multiple potential influences upon construction activity, a fixed schedule is not possible.

Comment 3 – Gravel removal will be limited to that which is necessary to construct the restoration tools and to compensate for decreases in the base flood capacity resulting from restoration measures. The quantity of gravel removal will vary from tool to tool and from site to site. Excavations to retain channel capacity and construct channel stabilization pools as well as excavations to perform maintenance will be based upon hydrological analyses. Implementation of maintenance measures will be subject to the same restrictions applicable to the original construction.

Comment 4 – Use of eco fences, secondary channels, and off-channel pools to restore fish and wildlife habitat in a high energy environment such as exists at the four restoration sites is essentially a new approach. Spur dikes and anchored root wad logs are widely known methods for diversifying fisheries habitat. See response to comment 1.

Response to Jackson Hole Conservation Alliance (Cont'd)

Comment 5 – Access to the general construction sites is discussed in paragraph 6.6 of the EA. Access where existing roads are not available would be coordinated in the field by Corps' personnel, a representative for the levee flood control project and appropriate landowners. Routes will be selected to avoid or minimize impacts to vegetation.

Comment 6 – Paragraph 6.8 of the EA addresses effects of construction, presence of completed structures, and maintenance upon recreational activity. As indicated in the EA, the local sponsor would implement a public information campaign to inform the recreating public about the project and how to recognize structures. Because some structures may be less readily recognizable due to variable conditions from site to site, marking of some structures may be appropriate. The Corps and local sponsor would evaluate the need for marking of certain structures. The local sponsor would erect signage deemed necessary as part of their public information campaign.

Edward R. and Shirley J. Cheramy
970 West Broadway, #438
Jackson, Wyoming 83001-9475
Phone: (307) 739-2157 Fax: (307) 733-2931

March 30, 1999

Walla Walla District
U.S. Army Corps of Engineers
Environmental Compliance
201 N. 3rd Avenue
Walla Walla, WA 99362-1876

Re: Snake River Restoration Project

ATTN: James S. Smith

Ladies and Gentlemen:

We live in Study Area 4 of the Snake River Restoration Project. Our eastern property line is the Snake River. We have attended all of the meetings related to this Project, have read the Environmental Assessment and have had discussions with various officials associated with this Project. We consider ourselves, as "laymen", to be thoroughly familiar with this Project.

We strongly support this Snake River Restoration Project and encourage you to
1 begin work on its full implementation as soon as possible. We see no negative
consequences to this project. In fact, we see negative consequences if the Project is
NOT done.

Please feel free to call us at 307-739-2157 if you would like to discuss this further.

Sincerely,

Edward R. Cherámy

Shirley J. Cheramy

Response to March 30, 1999 letter from Edward R. and Shirley J. Cheramy

Comment 1: Thank you for your comment.

Rec'd 4-12-9

Sewell Partners
4445 Moose Wilson Road
Wilson, Wyoming 83014
(307) 733-3989

April 1, 1999

Mr. James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Ave.
Walla Walla, WA 99362-1876

Re: EA on Jackson Hole Restoration Project

Dear Mr. Smith:

Sewell Partners owns property along the right bank of the Snake River
adjacent to the Taylor Creek #3 and Sewell Levees. Sewell Partners has been
1 and continues to be materially affected by the levee operation and
maintenance of the Corps of Engineers. This proposed restoration project
would also materially affect us.

The cover letter to the EA states that "The purpose of this project is to restore
fish and wildlife habitat lost as a result of construction, operation, and
2 maintenance of the levees constructed under the Jackson Hole Flood Control
Project..." We support this purpose and would like to see the project proceed,
but not in the piece meal fashion proposed. The Corps of Engineers has again
analyzed a small portion of the situation and refused to look at the whole.

This is a major federal action with many significant impacts. The proposed
action would significantly affect the quality of the human and natural
3 environment, and therefore an Environmental Impact Statement is required
pursuant to the NEPA. There are many reasons that this EA is inadequate
and that an EIS is required, but I will list only a few prominent ones.

4 This action is being considered piece meal: it should be analyzed
together with the ongoing maintenance, repair, and extensions of the existing
levees maintained by the Corps of Engineers.

The no action alternative was summarily rejected without sufficient
5 analysis. How can one compare the proposed alternative to the no action
when it is not included?

The alternative of protecting similar habitat that still exists along the
6 banks of the river but is unprotected by levees was not analyzed. If this EA
had looked at the whole flood plain instead of just the river channel, this
alternative would have been obvious and would have proved to be more cost
effective.

7 No significant analysis is given to the cumulative effects of this project when considered in the appropriate context of the overall levee system.

8 A finding of no significant impact is not supportable, and definitely is not supported by this EA. The Corps of Engineers should begin a full EIS process in the context of the whole Jackson Hole Flood Control Project.

Sincerely,

William B. Resor
general and managing partner
Sewell Partners

Response to April 1, 1999 letter from Sewell Partners

Comment 1: Thank you for your comment.

Comment 2: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 3: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

The Corps does not believe the proposed restoration measures warrant the level of analysis required of an Environmental Impact Statement. The proposed measures will not add to the baseline negative impacts attributable to the levees. The project is intended to diminish levee impacts by restoring portions of lost fish and wildlife habitat. We disagree that the project is being conducted in a piece-meal fashion. Past attempts to study opportunities for implementing restoration measures have been systematic within the limits of available time and funds and have considered areas both inside and outside the levees within the 500-year floodplain along approximately 25 miles of the Snake River. The Corps evaluated cumulative effects of the alternatives and determined the project has potential for beneficial effects regardless of whether the project encompasses one or numerous sites within the 500-year floodplain.

Those areas removed from further consideration due to limitations imposed by the agreement with the local sponsor are not precluded from future study. The Corps is hopeful that restoration measures at other areas along the Snake River may be studied and implemented in cooperation with a local sponsor.

Comment 4: See response to Comment 3 and response to the April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Cumulative effects are discussed in paragraph 6.11 of the EA. The Corps determined the proposed action would not add to the cumulative adverse effects caused by previous flood control actions at each of the 4 proposed restoration sites. In some instances, changes caused by the cumulative effect of actions proposed would cause non-beneficial effects of past flood control activities to diminish. Some restoration tools, such as spur dikes and bank barbs, were selected on the basis of their potential to lessen adverse effects of the river upon existing levees. The proposed action has significant potential for reducing erosion and damage of the levees in the immediate vicinity of each restoration site. Considerable opportunity for reduced levels of levee maintenance and repair could result.

Comment 5: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Response to April 1, 1999 letter from Sewell Partners (Cont'd)

Comment 6: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 7: See response to Comment 3 and response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 8: See response to comment 3.

11CC'C / 3 11

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Pinedale Resource Area
P.O. Box 768
Pinedale, Wyoming 82941-0768

WY (100)
1813

April 6, 1999

Peter F. Poolman
Planning Division, Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla Washington 99362-1876

Dear Mr. Poolman:

Thank you for the opportunity to comment on the Environmental Assessment for the proposed Jackson Hole, Wyoming Environmental Restoration Project. As you are likely aware, all of the four areas proposed for the restoration project contain at least a small amount of BLM public land. Therefore, we are very interested in any planned activities in these areas.

Comments from our staff are attached. We look forward to seeing the final EA and FONSI.

Sincerely,

Leslie A. Theiss

Field Manager

Enclosure

Bureau of Land Management, Pinedale Field Office
Comments on the Environmental Assessment for the Jackson Hole, Wyoming Environmental Restoration Project

	Page	Paragraph	Line	Comment
1	2	1-3		No reasonable alternatives to the proposed action are discussed; even the no action alternative was dropped from further consideration. The EA does not consider an adequate range of alternatives.
2	3-1	4	5	Spelling: *Oncorhynchus clarki*. Many other spelling errors occur throughout the text.
3	5-1	4	6-7	A permit will be required in order for any gravel to be removed from BLM lands. Depending on the type of permit granted, there may be stipulations on what uses the gravel may be put to after removal from the stream. All four Areas include at least a small amount of BLM land; it may be quite difficult to determine the ownership of gravels removed from the channel during construction.
4	5-10	1		During the life of the project, permits for removal of gravel from BLM lands will be necessary, including during maintenance activities.
5	6-13	1	1	Other parts of the document state that the project will allow island revegetation, reforestation, etc. This section says that "there may be enough protection in some areas to allow for langer survival of some plant species". This statement is not very strong, considering the stated goals of the project.
6	6-13	5	1	Replace "The trend of the habitat unit increases..." with "The trend of future habitat values increases..."
7	6-14	3	13	Monitoring will not ensure that weeds do not spread. Noxious weeds will be encountered in the project area. What is the plan for ensuring that weeds are not spread through both the project area and Jackson Hole?
8	6-20	1		Add wolf to the list of mammals that frequent Jackson Hole.
9	6-22	4	10	Should the lynx be moved the the T&E section?

10	6-39	3		This paragraph confuses the different restrictions on camping and other activities. As part of the lawsuit settlement, almost all the private lands along the river carry recreational easements granted to the BLM. The recreational restrictions on these lands are spelled out in the settlements and judgements. In general, boating, wading, hiking, picnicking, etc. are allowed, while shooting, hunting, open fires, and camping are not. These restrictions do not apply to the BLM lands; however, all the BLM lands were closed to camping several years ago to end chronic problems with summer employees living on the BLM lands.

11 **Concerning the sentence on pg. 5-2,** "The 4-inch minus material would be transported from the screening location by truck for **off-site upland disposal** prior to anticipated high flows" **and the sentence on pg. E-9 in Appendix E,** "Cobble, gravel, and sand not screened would be transported by truck to a permitted gravel processing facility for **disposal**." The question is, "Does **disposal** mean gravel sales by either the sponsor or contractor?" Any gravel that is obtained from public lands administered by the BLM and where permission to mine has been granted by a "Free Use Permit (FUP)," the extracted gravel must be used within the Project or for other public uses. The gravel may not be sold to help finance the Jackson Hole Restoration Project unless the local sponsor obtains, instead of a FUP, a "Negotiated Sale" BLM permit by paying "fair market value." In this case, the sponsor would need to purchase the gravel at the appraised value, probably between $0.75 and $1.50 per cubic yard. The BLM State Office would then to complete an appraisal to determine that fair market value.

The above statements also supply additional information for the sentences on pg. 7-4, "A permit must be obtained from the BLM prior to initiation of gravel removal from lands administered by that agency. The local sponsor would obtain the permit."

12 **Section 7.1.7 Wild and Scenic Rivers Act on pg. 7-2** probably needs to be further expanded or evaluated. I supply the following information for consideration:

I conducted a search of our office's Master Title Plats (MTP) covering the project area including townships 40N-116W, 40N-117W, 41N-116W, 41N-117W, and 42N-116W. These plats show land status and actions. The Snake River was designated a "Study River" from the southern boundaries of Teton National Park to the entrance to Palisades Reservoir under the Wild and Scenic Rivers Act. The MTP show that all townships except 41N-117W and 40N-117W have a Wild and Scenic Rivers Withdraw under Public Law 93-621 (WYW52152). The Withdraw states that "All public lands which constitute the bed or bank, or are within one-quarter mile of the bank, of any river which is listed in section 5 (study rivers) of this Act are hereby withdrawn from entry, sale, or other disposition under the public land lands of the United States for the period specified in section 7, subsection (b) of this Act." It is my understanding that these withdraws are still valid until Congress acts to either delete or select any portions of the study river. Until an "Opening Order" is issued to revoke the original withdraw, what is shown on the MTP is still valid. All of the Project area is free of these

Wild and Scenic River withdraws with the exception of public lands within Area 10 at the junction of the Gros Ventre and Snake Rivers (Secs 5-7, 18 of T.41N., R.116W. and Secs 2-4,9-10,16-17,20-21,28-29,31-32 of T.42N., R.116W.). It may be that the authority in the Flood Control Act of 1950 and the Water Resources Development Act of 1986 to build and maintain levees for flood control supersedes any Wild and Scenic Withdrawns in order to restore the original nature of the Snake River with its Scenic values.

Anyway, it is the author's opinion that the Wild and Scenic Withdraws of public lands described on the MTP have very restricted mineral material extraction authority and are like BLM's Wilderness Study Areas (WSA's) that do not allow mineral entry until Congress acts one way or the other to include those lands into the system. I may also make note that the BLM published in the Federal Register on June 1, 1995, Public Land Order 7143 (WYW 128871) that withdrew 5,937 acres of public lands and federal minerals along the Snake River for a period of 10 years. This action is to protect and preserve highly significant recreation, scenic, riparian, and wildlife resources until the BLM can complete a Land Use Plan (the Snake River RMP). The BLM is currently working on that NEPA document. The PLO described lands are withdrawn from settlement, location or entry under the mining laws, but not from leasing under the mineral leasing laws, exchange, or sales.

13 The Jackson Hole Wyoming Environmental Restoration Project has the potential to provide a limited amount of increased stability to portions of the Snake River channel but it does not address the root causes of the problems. However, within the constraints presented by society and available funding, the limited actions proposed could be more beneficial than taking no action.

14 The Snake River in the Jackson Hole area has several aspects that prevent the total recovery of the channel. The most prominent being the loss of the floodplain and the subsequent high dollar development behind the levies that prevents reallocation of land use to a more stable configuration. This, in combination with the past history of flow regulation from Jackson Lake Dam has produced a stream channel that is shorter and thus steeper than it would naturally be. As a result, there is excessive sediment transport and erosion of established channel features between the levees.

15 The proposed restoration projects do not significantly lengthen the channel but do make an attempt to reduce erosion by manipulating the flows from Jackson lake, deepening some portions of the channel, hardening some locations with structures, and increasing the average size of some of the sediment. If vegetation establishes behind some of the protected areas these changes may provide a measure of protection but will still require an active maintenance program.

16 Given the existing conditions between the levees, such actions have a greater potential to help than harm. They will not be the final solution to the problems along the Snake River but it is better than doing nothing.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management

Comment 1: The Corps previously evaluated, in an Environmental Assessment prepared under the authority of the 1986 Water Resources Development Act (Public Law 99-662), Section 1135(b), as amended, the potential of implementing environmental restoration measures outside of the levees. The Federal easements for access to private property outside of the levees, necessary to implement restoration measures, were not available. Consequently, the local sponsor withdrew sponsorship of the project and requested the Corps conduct a General Investigation Study to consider implementing restoration measures between the levees.

In June 1993, the Corps completed a Reconnaissance Report that concluded there to be a Federal interest in continuing the study of environmental restoration through the feasibility phase. The local sponsor subsequently entered into a cost-share agreement with the Corps to investigate the feasibility of implementing environmental restoration from Moose, Wyoming to the South Park feed grounds near Jackson, Wyoming. In January 1995, the Corps' responded with a Project Study Plan proposing restoration throughout the entire 500-year floodplain. The local sponsor rejected this alternative due to cost. Subsequently, evaluation was conducted to narrow the range of alternative sites to twelve. This significantly reduced the cost; however, it still proved to be outside of the sponsor's fiscal ability. Following further evaluation, the range of alternative locations was reduced to four. This proved to be within the sponsor's fiscal ability.

Because the current agreement restricts restoration measures to areas between the levees, alternatives that consider restoration measures outside of the levees were eliminated from further consideration. The parameters of that agreement also narrow the array of available tools to those most appropriate for in-channel siting.

During this process, the Corps' analysis determined Alternative 3, the preferred alternative, to be reasonable and feasible.. We also determined Alternatives 1 and 2 would be reasonable and feasible if money and time were of no consequence. All three alternatives would satisfy the project's purpose and need. Implementation of restoration measures at all areas adversely affected by the levees would appropriately address levee impacts upon the Snake River system. However, as indicated, such an approach was found to be unreasonable due to cost, resulting in the elimination of Alternatives 1 and 2. This also restricted the array of available tools to those most appropriate for in-channel siting between the levees.

The no action alternative was evaluated and eliminated from further consideration at the same time the other non-preferred alternatives were considered and eliminated. The no action alternative is also reasonable and feasible, however, it fails to satisfy the project's purpose and need. Should the local sponsor not choose to enter into construction, the no action alternative would become the selected alternative by default.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management (Cont'd)

The Corps recognizes the potential benefits of implementing alternate restoration measures at alternative locations outside of the levees and is hopeful local sponsorship of a study to evaluate and implement such an endeavor may occur in the future.

Comment 2: Your comment is noted and incorporated here as a revision to the EA.

Comment 3: Your comment is noted and incorporated here as a revision to the EA.

Comment 4: Your comment is noted and incorporated here as a revision to the EA.

Comment 5: This language is intended to acknowledge that the restoration tools may provide enough protection to allow longer survival of some plant species and thereby benefit the river by providing bank stability and organic matter. The restoration tools are intended to address the habitat degradation that has occurred within the leveed sections. Because the tools would be implemented in an environment where increased velocities have caused the loss of vegetation, reestablishment may occur rapidly, in very small increments, or, depending upon actions of the river, not at all at some restoration tools. Certain sites will experience a greater vegetation survival rate and experience greater longevity than will others.

Comment 6: Your comment is noted and incorporated here as a revision to the EA.

Comment 7: Teton County operates a Weed and Pest District. The local sponsor would coordinate with the Weed and Pest District on management of noxious weeds.

Comment 8: Your comment is noted and incorporated here as a revision to the EA.

Comment 9: Lynx was not a listed species under the Endangered Species Act (ESA) at the time the EA was drafted. Table 6-5 of the EA identifies lynx as a Priority III species as defined by the State of Wyoming. The lynx was evaluated along with other wildlife species in the area and potential effects are included in the EA. Should Lynx be formally listed under ESA the biological assessment would be updated to reflect the change in listing and any required consultation would be conducted.

Comment 10: Your comment is noted and incorporated here as an addition to the EA.

Comment 11: Thank you for requesting clarification. Gravel excavated from lands administered by BLM would either be used within the project or for public uses only. Gravel excavated from private lands would either be used within the project or would be transported to a permitted gravel processing facility for disposal.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management (Cont'd)

Comment 12: The Corps contacted BLM's regional office in Cheyenne, Wyoming and determined that the Wild and Scenic Withdraws are no longer valid.

Comment 13: Thank you for your comment.

Comment 14: Thank you for your comment.

Comment 15: Thank you for your comment.

Comment 16: Thank you for your comment.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 500
DENVER, CO 80202-2466

APR -5 1999

Ref: 8EPR-EP

James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith:

This letter is in response to your request for comments on the Environmental Assessment
(EA), Section 404(b)(1) Evaluation, and draft Finding of No Significant Impact for the proposed
Jackson Hole, Wyoming, Environmental Restoration Project. The Environmental Protection
Agency, Region 8, (EPA) appreciates the opportunity to comment at this time. We strongly
agree with the Corps that the Snake River floodplain in the Jackson Hole valley has been greatly
modified by the construction of federal and private levees. We want to point out that the
modifications continue to occur as a result of Corps and private actions and all efforts should be
taken by the Corps to assure that further encroachment into the floodplain does not occur. EPA
believes every effort should be made to avoid such impacts rather than have to conduct
"restoration" programs in the future. We also believe there are opportunities when existing
1 levees fail to allow the river to seek a natural path rather than reconstruct the levee. Perhaps this
EA should document the areas where this potential occurs, the institutional or environmental
constraints if any, and options to overcome them.

In the EA it is stated that several alternatives and actions were rejected due to cost. The
EA needs to include the actual cost information which was used to reject various actions so that
the reader can understand the significance of the cost issues. As cost seems to be the primary
reason cited for selection of the preferred alternative, the EA should discuss options to modify
2 the costs of the alternatives as well as opportunities to seek cost reimbursement from other
sources. As the "science" of channel restoration is new and continually evolving, the EA needs
to also present the costs for the various "tools" to be used for the channel restoration. This is
very important information because it allows the reader to compare this effort to other channel
restoration efforts. This will allow future efforts to better select the most appropriate method for
channel restoration of this nature.

The EA (page 5-8) indicates that the post project monitoring plan would be developed
prior to completion of the restoration project. EPA strongly believes that this plan needs to be
3 developed and agreed to by all the affected parties prior to project construction, and should have
been part of the EA so that public comment could have been received. The post-project

monitoring plan is one of the most critical parts of this project. Without detailed, long-term biological monitoring, it will not be possible to determine if the project purpose has been achieved. The implication of the EA is that major improvements in fisheries and cottonwood gallery habitat will occur because of the project. It will take many years of concentrated monitoring to determine if changes in fish standing crop and/or cottonwood recruitment success are attributable to the project features. The Corps should not underestimate the difficulty of this monitoring task, nor the long term cost. The EA indicates that the local sponsor will be required to conduct the monitoring and maintenance. The monitoring and maintenance plan needs to be finalized prior to, and included as part of the public works cost share agreement for this project. Without such sponsor commitment it is EPA's conclusion that a Finding of No Significant Impact cannot be reached.

On page 4-3 the EA indicates that gravel transport and deposition in the project area has decreased since completion of the levees. However, on page 5-9, the maintenance discussion indicates that maintenance of the channel stabilization pools, secondary channels, and off-channel pools will be necessary because they will fill with material being transported downstream. It is EPA's understanding that the Snake River in this area is still actively aggrading and this apparent conflict needs to be better explained. The discussion of the project maintenance requirements seems to indicate that this project may require a great deal of
4 maintenance for a very long period just to determine that the project goals (improved fisheries/cottonwood regeneration) will occur. We could not locate any case histories in the document discussing how long it may take the excavated project features to fill in. The Corps should examine other similar activities in area streams (instream gravel mining, levee repair, etc.) to determine the periodicity that instream maintenance may be required, and the potential costs of such maintenance. If the amount of material to be removed is large, the document needs to specify a disposal area, and the impacts at the disposal area.

Related to monitoring and maintenance, the current Teton County current stream restoration project at the Wilson Bridge was built with the primary purpose of determining if
5 these types of restoration structures would work. EPA does not believe that the proposed Corps project should be built until actual effectiveness, cost, and longevity data obtained at the Wilson Bridge demonstration is published and evaluated.

The hydrology discussion in section 6.1 of the EA does not supply information about the percent of time, or frequency that the flows will cause erosion/sedimentation of the proposed restoration structures. This is an important issue since if the excavated channel pools are refilled
6 on a regular basis the project benefits will not occur and project maintenance will be high, for negligible gains. From a vegetation perspective the created islands would need to be maintained for many years before mature cottonwoods could develop. The hydrology section should present the projected discharge at which the individual restoration features would fail, and the frequency at which that discharge is projected to occur.

The EA also contains a Clean Water Act §404(b)(1) evaluation in Appendix E. The §404(b)(1) Guidelines (40 C.F.R. 230) provide the substantive requirements for this evaluation. At §230.5 there are procedures which should be followed to conduct the evaluation. One of the

principal efforts of a §404(b)(1) evaluation is the project purpose statement. This is the statement on which the alternatives selection is to be based, and the subsequent evaluation for compliance with the restrictions (§230.10) made. We agree with the first sentence of the purpose statement contained at 1(c) of the evaluation and recommend that the project purpose be limited to that single statement. The second sentence of 1(c) tends to confuse the issue. We saw no indication in the EA of methods to "preserve or enhance" the project area. Perhaps it is a matter of semantics, but "restoration" should be used for activities that restore degraded systems to their natural potential. "Enhancement" should be reserved for activities that enhance functioning systems beyond their natural potential.

An essential part of the evaluation which is not included in Appendix E is the alternatives analysis. We recognize that the EA contains information on alternatives, and we noted some areas above where the existing alternatives analysis needs to be improved. However, we do not
8 see in the EA where all practicable alternatives to restoring habitat lost by levee construction have been included. For example, it would seem logical that since a major loss recognized in the EA is cutthroat spawning habitat, at least one alternative of opening access to a single spring stream somewhere within the levee system should be evaluated. The current proposal does little to supply increased spawning areas, although it may assist recruitment if it can provide additional protection for young-of-the-year. However, if recruitment is the actual project purpose, then other management tools to increase recruitment need to be evaluated. And we do not see the
9 necessary evaluation showing that the least damaging, practicable alternative has been selected. To be complete the evaluation should pay particular attention to the factors discussed at §230.12.

Again, we appreciate the opportunity to comment at this draft stage of the NEPA process and we look forward to working with the Corps as this project continues. If you have questions concerning our comments please contact Dave Ruiter at 303/312-6794.

Sincerely,

Cynthia Cody, Chief
NEPA Unit
Ecosystem Protection Program

cc: Mike Long, USFWS Cheyenne
Bill DiRienzo, WDEQ Cheyenne
Matt Bilodeau, Corps Cheyenne

Response to April 8, 1999 letter from United States Environmental Protection Agency

Comment 1: This environmental restoration project is being studied under the authority of the Study Resolution referenced in Paragraph 1.0 of the EA. The resolution directs the Corps to determine the advisability of compensating for fish and wildlife impacts resulting from construction, operation, and maintenance of the levees. Based on the language contained in the Resolution, the Corps believes considerations of alternatives for dealing with levee breaks are precluded from this study.

Additionally, the Corps feels that failure to maintain the levees would be contrary to Section 840 of the Water Resources Development Act of 1986. This Act authorizes the Corps to operate and maintain levees constructed under authority of the Flood Control Act of 1950, including levees constructed by non-Federal interests.

Comment 2: The specific cost of each tool will be factored into the feasibility of the project and will be discussed in the feasibility study. The EA uses general cost estimates to determine whether the size and magnitude of the project alternatives are manageable for the local sponsor and the Corps. The specific costs of the possible tool combinations will be set forth in the feasibility study. The EA sets forth sufficient information to allow the reader to evaluate the environmental effects of the tools and combinations thereof.

The local sponsor has explored other funding sources.

Comment 3: Thank you for your comment. The Corps recognizes the complicated and difficult task of monitoring. An in-depth plan designed to document the success or failure of various aspects of the project is currently under development and is being coordinated with appropriate resource agencies. The plan would be finalized prior to implementation of restoration measures. Monitoring would be conducted throughout the construction process. Adjustments and modifications would be made to ensure reasonable and adequate methods are used as the project progresses toward completion. Post-project monitoring is included in the plan.

Monitoring procedures have been slightly modified from those identified in the EA. Post-construction monitoring for at least a 10-year period was requested by one commenting agency in response to public review of the EA. Monitoring costs and duration were subsequently discussed between the local sponsor, the Walla Walla District and the Corps' Northwest Division. The issue was resolved through the decision for the Corps and local sponsor to share the cost of monitoring for a five-year period following completion of construction at each site. Phased construction would necessitate four years to complete all four sites. Post-construction monitoring would cumulatively encompass 8 years beginning with the monitoring of the first completed site and ending with the fifth year of monitoring for the fourth constructed site. The cost of pre-construction monitoring and monitoring during construction, as well as post-construction monitoring for the first five years to determine the need for

maintenance, would also be shared between the Corps and local sponsor. The local sponsor's share of five-year monitoring costs would be factored into the cost-share agreement. After the initial five years of monitoring at each site, the local sponsor would continue monitoring and bear all costs of monitoring necessary to determine the need for maintenance to structures. This maintenance monitoring would be conducted by the local sponsor for the life of the project. Actual maintenance measures would be later identified during the planning, engineering and design phase of the restoration project.

Comment 4: The reference in the EA on page 4-3 applies to Areas 1 and 4 only. The discussion indicates that gravel transport and deposition has only decreased. Transport and deposition of gravel has not ceased in Areas 1 and 4. We concur that aggradation (deposition) of gravel, though slowed from previous rates, appears to be continuing in Areas 1 and 4.

Discussion of Areas 9 and 10 are contained on page 4-2. The Corps' analysis indicates the leveed portions of Areas 9 and 10 have experienced a net loss of bed material (degrading). The rate of degradation also appears to be decreasing over time. Because materials continue to be deposited downstream at Areas 1 and 4, maintenance of channel stabilization pools, secondary channels, and off-channel pools would eventually be necessary. In Areas 9 and 10, even though a net loss of bed material is occurring, gravel is still being transported through these areas and being relocated and deposited locally within these areas. Maintenance of the channels and pools may continue to be necessary due to local deposition and the time required for some restoration measures (such as establishment of vegetation) to become fully effective.

As indicated on page 5-9, the quantity of sediment being transported downstream cannot be precisely calculated and will vary from year to year. Consequently, a channel stabilization pool may require several years to fill sufficiently to necessitate maintenance if it is located some distance from the main channel and if the channel doesn't move over to the pool location. However a single event could achieve the same result. The location of a pool with respect to the active channel is at least as important at the flood level. A variety of locations were selected for the pools in order to increase the probability that one or more pools would survive for an extended time. However, the Corps does not feel that additional analysis would yield data sufficiently reliable to predict the level of flow that may necessitate maintenance or to accurately predict the frequency with which such maintenance would be required.

Comment 5: See Response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1. The Corps will communicate closely with the local sponsor to obtain available effectiveness, cost, and longevity data on the various tools.

Response to April 8, 1999 letter from United States Environmental Protection Agency (Cont'd)

Comment 6: See response to Comment 4.

Comment 7: Your comment concerning use of the terms "restoration" and "enhancement" is noted. The term "preserve" is used in paragraph 1.c. to represent measures to protect aquatic and terrestrial habitat from loss or degradation. "Enhance" is used to represent measures to promote reestablishment of lost aquatic and terrestrial habitat.

Comment 8: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 9: Thank you for your comment. The following supplemental discussion is incorporated here as an addition to Appendix E, Clean Water Act, Section 404(b)(1) Evaluation, of the EA.

Three alternatives to restoring fish and wildlife habitat were evaluated in the EA. A 4th alternative, no action, was also evaluated. Each of Alternatives 1, 2, and 3 were capable of achieving the basic purpose of the project. However, Alternatives 1 and 2 were determined to not be practicable due to cost and logistics of obtaining access to areas outside of the levees. Costs associated with Alternative 3 were found to be practicable. Logistical issues associated with access were resolved for Alternative 3 by the restriction of work to areas between the levees only. The no action alternative would not achieve the project purpose.

Based on this, the Corps determined Alternative 3 to be the only practicable alternative that satisfies the project purpose. The Corps also feels there are no other practical alternatives having less adverse impacts that would better achieve the basic purpose of the project.

In order to satisfy the basic project purpose, discharges of dredged and fill material must occur in waters of the United States. Areas other than the four selected, and that are between the levees and suitable for restoration, are likely available. However, implementation of restoration measures at other locations between the levees would merely result in a similar level of effects and cost without tangible additional benefit. Based on this, no practicable alternative sites are considered available.

By letter dated April 9, 1999, the State of Wyoming, Department of Environmental Quality certified the project under Section 401 of the Clean Water Act.

Based on the above and the Corps' evaluation of the project under Subparts C through G of the Guidelines (See Appendix E to the EA), the project would comply with Part 230, Section 404(b)(1), Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

WYOMING GAME AND FISH DEPARTMENT

Jim Geringer, Governor   John Baughman, Director

"Conserving Wildlife — Serving People"

April 9, 1999

WER 5225
U.S. Corps of Engineers
Walla Walla District
Environmental Assessment
Section 404(b)(1) Evaluation and Draft Finding of
No Significant Impact Project
Public Notice Number CENWW-PD-EC 99-01
Environmental Restoration Project
Jackson Hole Flood Control Project
Teton County

Walla Walla District, Corps of Engineers
Environmental Compliance Branch
ATTN: James S. Smith
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith:

The staff of the Wyoming Game and Fish Department has reviewed the Environmental Assessment, Section 404(b)(1) Evaluation and Draft Finding of No Significant Impact for the proposed Jackson Hole, Wyoming, Environmental Restoration Project. We offer the following comments for your consideration.

<u>Terrestrial Considerations:</u>

1 According to the Environmental Assessment (page 1), construction of levees have reduced the available floodplain, resulting in increased water velocities, unstable channel configurations, elimination of natural channel braiding, and erosion of islands and associated vegetation. Loss of terrestrial habitat (shrub-willow and cottonwood-riparian areas) that provides habitat for a number of passerine birds, raptors, and large and small mammals has also been documented.

2 The Environmental Assessment documents serious declines in both the quantity and quality of riparian habitat. Riparian habitat within the levees has decreased from 2,761 acres in 1956 to 1,176 acres in 1986, cottonwood regeneration has declined, and cottonwood-spruce habitat has replaced riparian habitat behind the levees (page 3-1). Although not mentioned in the

Headquarters: 5400 Bishop Boulevard, Cheyenne, WY 82006-0001
FAX (307) 777-4610

Environmental Assessment, continued construction of human residences behind the levees within
the flood plain has also resulted in a loss of riparian habitat and displacement of wildlife.

The Snake River corridor and associated riparian areas contain some of the most valuable
wildlife habitat for a variety of resident and migratory species. Nesting bald eagles along this
corridor have contributed substantially to recovery of this species within the Greater Yellowstone
3 Ecosystem. The river corridor provides nesting, roosting, and foraging habitat for a variety of
bird species; cover, foraging and wintering habitat for large and small mammals; and habitat for
amphibians and reptiles. It also provides an extremely important movement corridor for wildlife
within the Jackson Hole area.

The Environmental Assessment includes a brief description of the wildlife species found
within the project area and also includes, as Appendices, the Biological Assessment (Appendix
A) and the U.S. Fish and Wildlife Service Coordination Act Report (Appendix B). We have
reviewed these documents. Following are comments and suggestions:

1. The Environmental Assessment monitoring plan calls for post-project monitoring only (page
5-8). We suggest, since the project will not be initiated until 2001, that 1-2 years of pre-
project monitoring be undertaken in the four project areas, especially during the actual time
periods of the year when the proposed project work will take place. Collection of baseline
4 data on wildlife use of these areas would provide information for development of specific
mitigation measures to avoid disturbance during project implementation, and also would
provide baseline data for comparison with post-project monitoring. Data on current bald
eagle foraging and roosting locations, and on resident amphibian populations, would be
especially useful.

5 2. Post-project monitoring should continue for at least 10 years, and should include detailed
documentation of vegetation changes and surveys of game and non-game species.

6 3. The data included in the Environmental Assessment on bald eagle nest locations does not
include locations for all known alternate nests (page 6-28). We encourage the Corps to
coordinate closely with the Department's Nongame Biologist in Jackson to obtain locations
of alternate nest sites, as well as any new nest locations during project implementation. We
suggest the Corps also review and implement management guidelines from the following
report: *Bald Eagles in the Greater Yellowstone Ecosystem* (WGFD, Dec. 1992).

7 4. Of the four project areas, three (Areas 1, 4, and 10) fall within the primary management zone
(Zone I, 400 meters) of nesting pairs of bald eagles. Management guidelines recommend that
within this zone, habitat alternations should only occur for the maintenance or enhancement
of nesting habitat (WGFD, Dec. 1992: Table 57). We are especially concerned about Area
10, as it has recently experienced increased disturbance due to home construction in the
immediate area. We suggest that project work not take place until after the young have

dispersed from this territory (early to mid September). We also recommend that bald eagle activity be monitored prior to, during, and after project implementation at all territories.

8 5. The Environmental Assessment mentions two species of owls that occur occasionally in the project areas (great gray and flammulated) but does not mention other species that likely nest within the Snake River corridor. These include great horned owl, long-eared owl, pygmy owl, and saw-whet owl. These should be added to the list of species. The statement:
9 "Raptors would avoid construction activities until they habituate to it." (page 6-26) should be deleted, as it is not clear that such habituation would in fact take place.

10 6. We recommend avoiding construction activities in ungulate migration corridors during spring (April-May) and fall (Nov-Dec) migration periods. If work needs to be completed during such times, it should be closely coordinated with Regional Department personnel to develop site-specific mitigation measures.

11 7. Trumpeter swans winter within the project areas, and have been observed this winter in areas 9 and 10. Construction of some reclamation ponds to enhance winter foraging is encouraged. We recommend the Corps coordinate with the Department for input on pond construction and vegetation that would benefit this species.

12 8. Data on amphibians (Environmental Assessment, page 6-27) include some incorrectly spelled scientific names (*Rana* not *Ranu*) and incomplete distribution information. In the Jackson area, spotted frogs and boreal chorus frogs are considered common, the boreal toad is likely declining in abundance, and the northern leopard frog is extremely rare and maybe extinct (*Amphibians and Reptiles of Yellowstone and Grand Teton Parks*, Koch and Peterson, 1995). We suggest that surveys for amphibians be conducted by experienced field biologists in all project areas, and that breeding habitat, especially for boreal toads, be identified and protected. Tadpoles could still be present in pools in mid-August when construction activities take place. Concentrations of tadpoles or metamorphs should be protected or moved from construction areas.

13 9. We are concerned that annual maintenance may be needed for restoration features, and this may result in repeated and on-going disturbance in the project areas. We encourage the Corps to carefully evaluate proposed restoration techniques in the demonstration area (Area 9) prior to implementation in other areas to ensure that repeated restoration does not result in long-term disturbance to resident wildlife populations. This disturbance may outweigh proposed benefits. If it becomes apparent that stabilization and regeneration projects in riparian areas are not being achieved, the project design should be modified.

14 10. We concur with the U.S. Fish and Wildlife Service (in the Coordination Act Report) that, although this project may assist in the restoration of limited fish and wildlife habitat, a

system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by levees along the Snake River.

Aquatic Considerations:

We support the concept of the proposed restoration project, but doubt if the objectives of the project are actually attainable given the constraints of having to work within the existing (and expanding) levee system. With this in mind, we offer the following comments:

2.0 Project Purpose and Need -- This section seems to present the argument that the proposed project will restore all habitats lost due to the construction of the Jackson Hole Flood Control Project. At most, any habitat created by the proposed restoration project will be a small
15 percentage of habitats lost over the last several decades due to flood control activities. The only way restore any significant percentage of lost habitats would be by removing levees.

4.0 Four Alternatives Considered -- We believe another alternative, or an add-on to the
16 described alternatives should be included. This would be for the Corps of Engineers to provide funding to maintain spawning habitat in Snake River tributaries.

5.1.5 Off-Channel Pools -- Off-channel pools **will not** provide any spawning habitat. Also, as mentioned in previous correspondence, we caution removal of gravels in some side channels. If proper design and location are not considered, some newly created resting pools could ultimately
17 be prime areas for fish entrapment during periods of low flows. All side channels where gravel is to be excavated need to maintain enough surface flow throughout the flow regime to allow fish utilizing these pools to move in and out of these areas. In addition, as documented by our sampling this past winter, there exists the potential for dissolved oxygen conditions to drop to lethal levels for salmonids in these pools if there is not sufficient flows.

6.2 Aquatic Environment

6.2.1.1 Cutthroat Trout (Habitat Quantity and Quality Assessment) -- How the assessment of habitat units (with and without project) was determined is unclear. Though
18 the relationships shown in Figure 6-1 may be accurate for a given site, the benefit of this project to the Snake River system as a whole will be negligible and should be noted. Also, unless there is a high level of maintenance on these created habitats, they too will degrade over time.

19 We disagree with the statement indicating this project will lead to "healthier" cutthroat. Although, more fish may overwinter, there is no indication any fish will be "healthier".

20 **6.2.1.2 Other Game Fish Species** -- *Salvelinus* is misspelled. *Namaycush* is misspelled.
21 Delete arctic grayling from this list. There is only one documented occurrence of
22

grayling in the Snake River, and this individual probably drifted down from Toppings Lake.

23 <u>6.3.2.5 Reptiles and Amphibians</u> -- In regards to the boreal toad, it should be noted that there are two recognized populations of boreal toads in Wyoming. The project area is within the distribution zone for the northern population. The southern population inhabits the Snowy Range and Sierra Madre Mountains in south-central Wyoming. The southern population is considered a "candidate" species under the Endangered Species Act, and has been the focus of a recently signed habitat conservation plan.

24 <u>6.3.2.6 Threatened and Endangered Species</u> -- The Yellowstone cutthroat trout has been petitioned to the U.S. Fish and Wildlife Service for listing under the Endangered Species Act. Under this petition, the Snake River cutthroat trout is addressed as and considered to be a form of Yellowstone cutthroat trout. Although the Wyoming Game and Fish Department recognizes the Yellowstone and Snake River cutthroat subspecies to be distinct and separate, this issue should be addressed in this document.

25 <u>6.7 Socioeconomics (page 6-38)</u> -- The document states that over the 50-year project period the average annual fish numbers will be maintained. However, if the spring tributary systems are not maintained, the proposed project will provide no long-term benefit to Snake River cutthroat trout populations. **The position of the Wyoming Game and Fish Department is that the key to maintaining the Snake River fishery is in maintaining/enhancing the quality and access to the spawning areas in the spring creeks.**

26 <u>6.8 Recreation (page 6-38)</u> -- We disagree with the statement that the South Park area receives limited public recreational use. Please contact Steve Kilpatrick in our Jackson Office to obtain accurate information.

We appreciate the opportunity to comment on this project and encourage the Corps to coordinate closely with our agency throughout the life of this project.

Sincerely,

Bill Wichers

BILL WICHERS
DEPUTY DIRECTOR

BW:TC:as
cc: Bill DiRienzo-DEQ/WQD
Dave Ruiter-EPA
USFWS

Response to April 9, 1999 letter from Wyoming Game and Fish Department

Comment 1: Your comment is noted and incorporated here as an addition to the EA.

Comment 2: Your comment is noted and incorporated here as an addition to the EA.

Comment 3: Your comment is noted and incorporated here as an addition to the EA.

Comment 4: We agree that long-term pre-project monitoring would provide a better picture of the project's effects upon wildlife populations in the four areas. However, 1-2 years of pre-project monitoring is currently not feasible under the existing budget and schedule. Given this limitation and the uncertainty of when construction may occur in each area, the Corps feels the most prudent approach is to monitor for impact avoidance. This type of monitoring would be performed during the last 30-day period prior to the start of construction and carry through the construction itself. Short-term pre-project monitoring is included in a monitoring plan currently being developed and distributed for coordination with multiple resource agencies, including Wyoming Game and Fish Department.

Comment 5: See response to April 8, 1999 letter from United States Environmental Projection Agency, Comment 3. Monitoring would include documentation of wildlife habitat and vegetation changes. See response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1.

Comment 6: Pre-construction monitoring and monitoring during construction would include coordination to identify locations of alternate next sites as well as new nest locations.

Comment 7: Thank you for your comment. The BA, Appendix A to the EA, discusses monitoring of bald eagle activity prior to and during construction. Paragraph 5.2 of the EA discusses post-project monitoring. Bald eagle activity would be monitored during pre-construction, construction, and post-construction. See response to Comment 5. The Corps intends to work closely with Wyoming Game and Fish Department during pre-construction and construction to minimize impacts upon significant wildlife resources.

Comment 8: Thank you for your comment. The list in the EA identified sensitive species found in the area and included only some of the locally common species. The great horned owl is identified in paragraph 6.3.2.4.2 of the EA. The remaining species mentioned in your comment, long-eared owl, pygmy owl, and saw-whet owl are noted and incorporated as an addition to the EA.

Comment 9: Thank you for your comment. The great-horned owl has been documented to habituate to human disturbance, however habituation may or may not occur. Habituation likely would not occur if construction is short-lived. The 1st sentence of the 7th paragraph on page 6-26 of the EA is replaced with the following sentence and is incorporated as a revision of the EA: "Raptors would likely avoid construction areas until construction disturbances have ended or until they habituate to the disturbance".

Comment 10: Thank you for your comment. Paragraph 6.3.2.2 of the EA discusses timing restrictions relating to ungulate migration and coordination with Wyoming Game and Fish Department personnel.

Comment 11: Thank you for your comment. Impacts to trumpeter swans are discussed in paragraph 6.3.2.4 of the EA, as well as in the CAR, Appendix B to the EA. The Corps recognizes the variety of fish and wildlife habitat that exists in the area, including the importance of foraging habitat for trumpeter swans. Several restoration tools have been identified in the EA to address both aquatic and terrestrial habitat. Reclamation ponds to specifically enhance foraging habitat for trumpeter swans was not identified as a recommended tool during the numerous project planning meetings and therefore, is not included among the planned restoration tools. The Corps would consider investigation of reclamation ponds as a restoration tool on any future restoration cost-share studies.

Comment 12: Thank you for your comment.

Comment 13: See Response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1. Additionally, the Corps intends to make modifications to the restoration tools as new information is gathered through the demonstration project and throughout construction at the restoration sites. Modifications would be intended to maximize habitat protection and establishment, and improve structure function and integrity, thereby reducing the potential need for annual maintenance.

Comment 14: The Corps acknowledges that this project would not restore all fish and wildlife habitat that has been destroyed or degraded. The Corps is hopeful that future cost-share agreements with a local sponsor may be entered to continue the protection and restoration efforts.

Comment 15: Thank you for your comment.

Comment 16: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Response to April 9, 1999 letter from Wyoming Game and Fish Department (Cont'd)

Comment 17: Your comment on spawning habitat is noted. The words "spawning and" are deleted from the 1st sentence of paragraph 5.1.5 of the EA. This change is incorporated as a revision of the EA. In addition, off-channel pools would be constructed with these considerations in mind. Post-construction monitoring would be conducted to ensure adequate flows.

Comment 18: Figure 6-1 represents a combined estimate of fish habitat unit projections for the four restoration areas and, therefore, is not intended to represent any single site. The Corps recognizes that each site is different and that the quantity and quality of fish habitat that may be restored will vary from site to site. The Corps also recognizes there are numerous areas along the Snake River that could benefit from restoration efforts and that any benefits derived from restoration in the four areas would be a small portion of any overall potential benefits. Monitoring would be used to assess the level of maintenance necessary for the various tools.

Comment 19: Healthier is used to refer to the possibility that increased resting areas could lead to a lower density of fish per resting area. A lower density of fish per resting area can result in less competition or stress, which could lead to larger or healthier fish after the critical winter period.

Comment 20: Your comment is noted and incorporated here as a revision of the EA.

Comment 21: Your comment is noted and incorporated here as a revision of the EA.

Comment 22: Your comment is noted and incorporated here as a revision of the EA.

Comment 23: Thank you for clarification on this issue. Your comment is noted and incorporated here as an addition to the EA.

Comment 24: Effects of the project upon Snake River cutthroat trout are included in the EA. Should Snake River cutthroat trout be formally listed under ESA, the Biological Assessment would be updated to reflect the listing and any required consultation would be conducted.

Comment 25: Thank you for your comment. The Corps recognizes the importance of access to quality spawning areas in the spring creeks and has attempted in the past to implement restoration measures outside of the levees. See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1. The Corps would gladly work with a local sponsor under a cost-share agreement to investigate the feasibility of implementing measures to improve access to spawning areas in the spring creeks. Additionally, the Corps would require the local sponsor to acquire conservation easements to protect improvements to spawning areas.

Response to April 9, 1999 letter from Wyoming Game and Fish Department (Cont'd)

Comment 26: Thank you for your comment and recommendation. The Corps contacted Mr. Steve Kilpatrick of Wyoming Game and Fish Department in Jackson, Wyoming. Mr. Kilpatrick indicated that recent completion of a paved bike path that connects to the South Park Habitat Management Area road system, which connects to the levee system, has resulted in recent increases in public recreational use. The paved path is open to biking, hiking and horseback riding. He estimated the levees in the South Park area receive moderate use from about May 1 through mid-July and heavy use from mid-July till September. Presently, hiking/walking is the most prominent use. Biking is expected to increase substantially as more people become aware of the inter-connecting path, roadways and levees. This new information is incorporated as an addition to the EA.

The State
of Wyoming

Department of Environmental Quality

Jim Geringer, Governor

Herschler Building • 122 West 25th Street • Cheyenne, Wyoming 82002

ADMIN/OUTREACH	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZ. WASTE	WATER QUALITY
307-777-7758	307-777-6145	307-777-7391	307-777-7369	307-777-7756	307-777-7752	307-777-7781
FAX 777-3610	FAX 777-6462	FAX 777-5616	FAX 777-6937	FAX 777-5864	FAX 777-5973	FAX 777-5973

April 9, 1999

James Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, WA 99362-1876

RE: **Certification of pending Environmental Restoration Project on the Snake River, located in various adjacent sections in T40N, R117W and T41N, R117W Teton County**

Dear Mr. Smith:

According to the provisions of the state certification program for activities requiring dredge and fill permits from the U.S. Army Corps of Engineers, this office has reviewed the above said application and offers the following comments regarding the proposed action:

As you know, the Snake River is listed as having two separate classifications as a surface water of
the State. The portion of the river upstream of the Wyoming Highway 22 bridge is classified as a
1 class 1 water, the remaining downstream portion is a class 2 water. Class 1 waters are those surface
waters in which no further water quality degradation by point source discharges, other than from
dams, will be allowed. Class 2 waters are those waters presently supporting game fish; or have the
potential to support game fish; or include nursery areas or food areas for game fish.

Class 1 and class 2 waters have essentially the same standards applied to them to protect aquatic
habitat. The discharge of solids must not be present in quantities that could result in degradation to
the existing aquatic habitat. Additionally, turbidity created from the discharge of solids must not
2 result in an increase greater than 10 NTU's above upstream levels. The environmental assessment
(EA) completed for this project addresses this concern and proposes a monitoring program to insure
impacts do not exceed state standards. The DEQ has no additional conditions to place on this project
as long as activities are carried out as described in the EA.

The Wyoming Department of Environmental Quality certifies this project is acceptable providing construction is accomplished according to the above stated recommendations, and you take
3 reasonable care to ensure that all disturbed areas are protected from erosion. The Department also reserves the right to amend, modify, suspend or revoke this certification or any of its terms or conditions as may be appropriate or necessary to protect water quality and associated beneficial uses.

Please be aware that this letter only constitutes state certification of this project as required by Section 401 of the Federal Clean Water Act. This letter does not exempt the Corps from any other federal, state or local laws or regulations, nor does it provide exemption from legal action by private citizens for damage to property that the activity may cause.

Sincerely,

Dennis Hemmer
Director
Department of Environmental Quality

DH/GB/CA/mad 9077.8.ltr

cc: Tom Collins, Wyoming Game and Fish, Cheyenne
Dave Ruiter, EPA, Denver (8 EPR-EP)
Mike Long, US FWS, Cheyenne

Response to April 9, 1999 letter from the State of Wyoming, Department of Environmental Quality

Comment 1: Thank you for your comment.

Comment 2: Thank you for your comment.

Comment 3: Thank you for your comment and review of the project under the Guidelines established under Section 404(b)(1) of the Clean Water Act.

JACKSON HOLE, WYOMING, ENVIRONMENTAL
RESTORATION PROJECT
ENVIRONMENTAL ASSESSMENT

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GLOSSARY OF TERMS

Bank Barb: Rigid, riprap structure projecting into the current from the bankline. Its function is to deflect the current away from the bank, trap sand, provide flow diversity, and resting places for fish and other aquatic organisms. Dimensions vary, and the typical length averages 26 feet.

Channel Capacity Excavation: The excavation of riverbed cobble and gravel to increase flow capacity of the channel. Channel capacity excavations compensate for decreases in channel capacity resulting from deposition of bedload material and sediments and constricts flow to reduce erosion of point bars and islands.

Channel Stabilization Pool: See definition of sediment trap.

Eco Fence: A structure designed to trap and retain floating woody debris. Two types are referenced in the Environmental Assessment: Rock Eco Fence and Piling Eco Fence. The fences are employed to reduce erosion and to promote deposition. Flow velocities are reduced immediately downstream of fences, causing deposition of sediments. Deposited sediments facilitate bar/island formation and provide opportunity for establishment of vegetation. Fences also prevent erosion of existing bars/islands located immediately downstream.

Hack Sites: Acclimation area for raptors being reintroduced to the region.

Kicker: Same as a bank barb, except the kicker has a gravel and cobble core and a typical length averages 56 feet.

Off-Channel Pool: A pool constructed adjacent to the main channel. This serves as overwintering and rearing habitat for juvenile Snake River fine-spotted cutthroat trout and is used as a resting area by waterfowl.

Ordinary High Water Mark (OHWM): This is the general average elevation of annual ordinary high flows for a particular waterway. A line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate physical characteristics

Palustrine Scrub-Shrub (PSS): A class of wetland dominated by woody vegetation less than 20 feet tall. Includes true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. It is a successional stage of vegetation often leading to forested wetlands on river floodplains as islands.

Palustrine Forest (PF): A class of wetland characterized by woody vegetation that is 20 feet tall or taller.

Piling Eco Fence: An eco fence constructed of driven steel piles with inter-connecting cables. See definition of eco fence.

Rock Eco Fence: An eco fence constructed of riprap. See definition of eco fence.

Rock Grade Control: A layer of riprap forming a weir to prevent erosion or down-cutting of channel.

Root Wad Log: A tree trunk with a root wad attached. It is anchored in cobble to provide in-stream woody debris and promote sediment deposition.

Secondary Channel: A channel constructed adjacent to the main channel to transport flow to and from off-channel pools.

Sediment Trap: The excavation of riverbed cobble and gravel to create area of low-velocity flow so that bedload material drops out of the flow and is not transported further downstream.

Side Pool: See definition of off-channel pool.

Spur Dike: Spur dike usually refers to a single structure. However, as used in this environmental assessment the term represents a series or grouping of multiple bank barbs or kickers (as shown on the plates contained within this document).

Staging Area: Area for storage and dispensing of equipment fuels and lubricants. Also an area for equipment storage overnight or during nonuse.

Supply Channel: See definition of secondary channel.

ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BLM	Bureau of Land Management
CAR	Coordination Act Report
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Corps	U.S. Army Corps of Engineers
DEQ	Department of Environmental Quality
EIS	Environmental Impact Statement
FIS	Flood Insurance Study
FONSI	Finding of No Significant Impact
HEC	Hydrological Emergency Center
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
kaf	1,000 acre-feet
NEPA	National Environmental Policy Act
OHWM	Ordinary High Water Mark
PF	Palustrine Forest
PSS	Palustrine Scrub-Shrub
SHPO	State Historic Preservation Office
USGS	U.S. Geological Service
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WGFD	Wyoming Game and Fish Department
WYNDD	Wyoming Natural Diversity Database

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION PROJECT ENVIRONMENTAL ASSESSMENT

1.0 INTRODUCTION

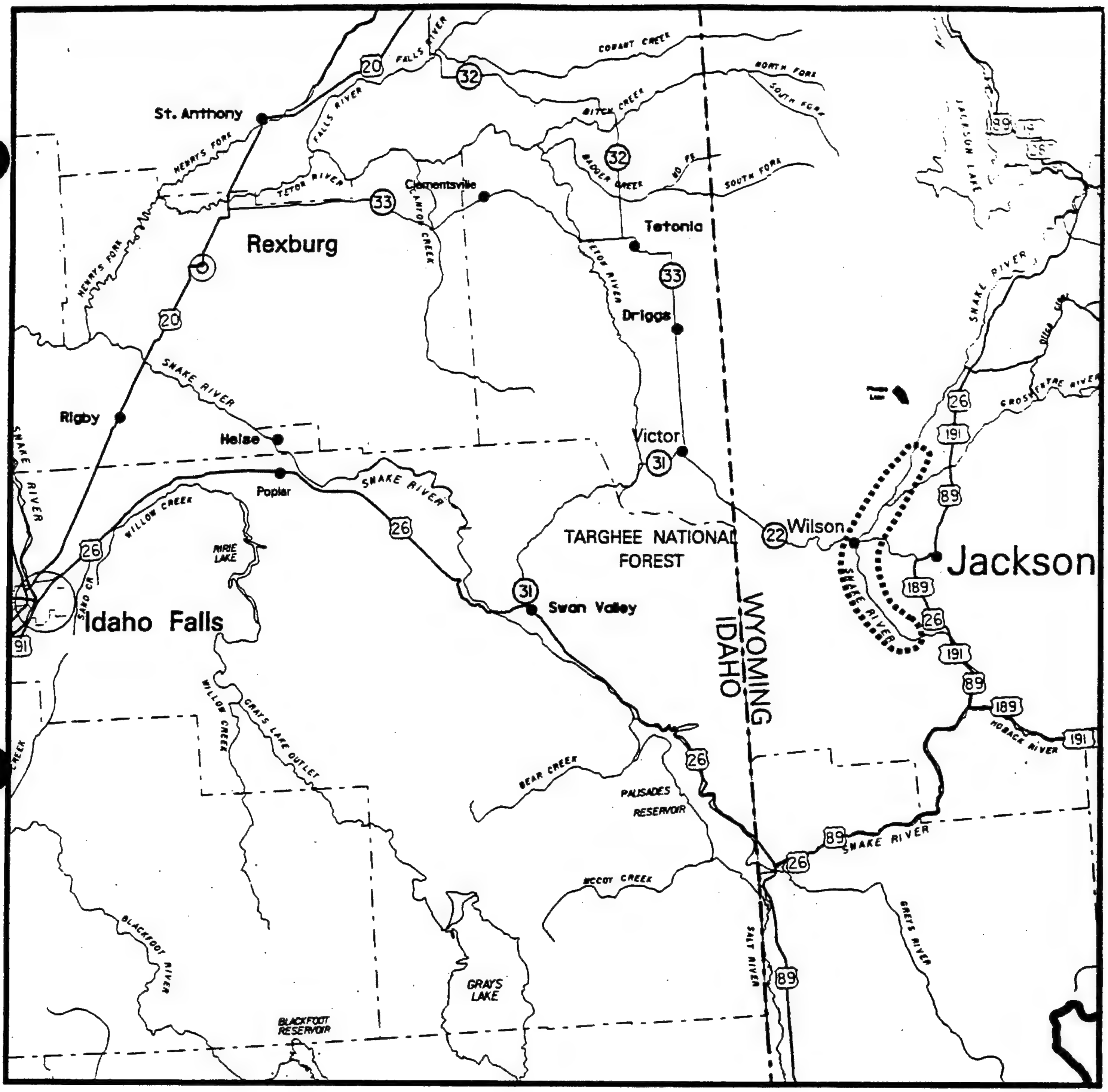
This environmental assessment (EA) considers the effects of restoring wetland and riparian habitats in the Snake River, between Grand Teton National Park and South Park Elk Feed Grounds near Jackson, Wyoming (figure 1-1 and plate 1). The proposed Jackson Hole, Wyoming, Environmental Restoration Project would involve channel stabilization measures to protect and increase fisheries habitat, island protection measures to preserve riparian island values, island environmental restoration measures to restore lost riparian values, and stream structure alteration to create fish habitat. The environmental restoration project is proposed in response to environmental resource impacts resulting from levees constructed under the Jackson Hole Flood Control Project.

The Jackson Hole Flood Control Project was authorized in the Flood Control Act of 1950, and provided flood protection by levees and revetment along the Snake River in Jackson Hole, Wyoming. The Jackson Hole Flood Control Project was completed in the fall of 1964, and the sponsor was Teton County. Additional levees were added to the system by other agencies and by "emergency flood fight" operations of the U.S. Army Corps of Engineers (Corps) and Teton County through 1997.

Authority to operate and maintain the Jackson Hole Flood Control Project was granted by Section 840 of the Water Resources Development Act of 1986 (Public Law 99-662) to the Secretary of the Army, including additions and modifications constructed by non-Federal sponsors, provided that the local sponsor provides the first $35,000 in any one year (adjusted for inflation). The Corps signed a Local Cooperative Agreement with Teton County in September 1990, after completion of a Decision Document and Environmental Impact Statement (EIS). The Corps assumed operation and maintenance responsibility for the levee system on the Snake and Gros Ventre Rivers in Jackson Hole, Wyoming.

The Jackson Hole, River and Wetland Restoration Study, Wyoming, was authorized by the U.S. Senate Committee on Environment and Public Works in a Study Resolution of June 12, 1990. The scope of the study was to determine the feasibility of providing environmental restoration to wetland and riparian habitats located between the flood control levees. Teton County, the local sponsor for the proposed environmental restoration project by the Corps, would provide funds in accordance with cost sharing requirements specified in Public Law 99-662, as amended.

As required by the National Environmental Policy Act (NEPA) of 1969 and subsequent implementing regulations promulgated by the Council on Environmental Quality (CEQ), this EA was prepared to determine whether the proposed environmental restoration project constitutes a "...major Federal action significantly affecting the quality of the human environment..." and whether an EIS is required.



NOT TO SCALE

PROJECT LOCATION

Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

VICINITY MAP

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2.0 PROJECT PURPOSE AND NEED

The purpose of this environmental restoration project is to restore fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of levees constructed under the Jackson Hole Flood Control Project, including levees constructed by non-Federal interests. The project is located in the Snake River, near Jackson, Teton County, Wyoming.

While the levees have contributed significantly toward reducing flood damage potential along the river corridor, over time the levees have significantly changed the physical character of the river system and contributed to the loss of environmental resources. This environmental restoration project is needed to prevent further degradation and destruction of environmental resources within the study area and to facilitate recovery of lost aquatic and terrestrial habitat. The project has high potential for restoring fish and wildlife habitat through enhancement and restoration of the aquatic and terrestrial environment, including wetland and riparian vegetation and in-stream fisheries habitat.

3.0 EXISTING CONDITION

Flow velocities in both the main channels and the secondary channels tend to be high, due to the general steepness of the valley. Due to the high transport of bedload, the channel bed complex is constantly changing. During high flows, avulsion of the main channel into side channels is common. When the flow erodes a gravel bar or the main channel becomes clogged with debris, the flow can shift direction suddenly and unpredictably. However, construction of the Federal and non-Federal levees along the Snake River blocked the lateral spread of the river and reduced the width of the floodplain and the degree of randomness of the braided system. This limited the ability of the channel to migrate and restricted avulsion activity to the area between the levees, concentrating flows in the existing main channels and increasing the frequency of attack on islands and vegetation between the levees. The flow concentration and increased frequency of attack is preventing the natural recovery of islands and vegetation. Bedload materials, brought into suspension by the turbulent flow, are more likely to be carried through the system rather than being carried laterally into the slower secondary channels where they could be redeposited over a wider area of the floodplain.

Flood damages include loss of land due to bank erosion, loss of shrub-willow and mature cottonwoods, and damage to levees due to erosion or undercutting.

The quantity of riparian habitat, within the levees, has decreased from 2,761 acres in 1956 to 1,176 acres in 1986. The quality of the remaining riparian habitat has also declined (Corps 1998). The area of cottonwood forest behind the levees remained approximately constant between 1956 and 1986, but the quality of this habitat has been reduced. The percent of mature cottonwoods has increased behind the levees, indicating that cottonwood regeneration has declined. There was a 149 percent increase of cottonwood-spruce habitat from 1956 to 1986 behind the levees, indicating a loss of riparian habitat. The loss has been compounded by the side channels and spring creek habitats being cutoff from the river by the levees (Corps 1998).

The Snake River, in part of the area of the proposed action, is designated a Class 1 trout fishery by the Wyoming Game and Fish Department (WGFD). This designation signifies the river is of national importance as a trout fishery. This fishery is composed primarily of Snake River fine-spotted cutthroat trout (cutthroat trout) (*Oncorhynchus chlarki* spp). Numerous other game fish and non-game fish are present [U.S. Fish and Wildlife Service (USFWS) 1990]. Spawning habitat for the cutthroat trout is considered one of the major factors limiting population for this species in the upper Snake River drainage. Little or no spawning habitat exists in the main river because high flows, particularly during spring runoff, produce large sediment bedloads and turbidity during the spawning period. Spawning habitat losses have occurred from human activities, including diversions for irrigation and levee construction (USFWS 1990).

A variety of wildlife species, which use the Snake River in the environmental restoration project area, are affected by declines in wetland and riparian vegetation. including shrub-willow and cottonwood. Bald eagles (listed threatened by the USFWS) actively nest in close proximity to the project area. Bald eagles commonly use the snags (woody debris) and large living trees along the river for nesting and roosting (Corps 1994). Peregrine falcons often forage within the project areas. This species is presently classified as endangered by the USFWS and as Native Species Status 3 by the State of Wyoming due to restricted habitat availability and declining populations. Resident and migratory waterfowl use the Snake River and its tributaries for spring and fall staging, breeding, nesting, brood rearing, and wintering habitat (USFWS 1990). A large variety of other wildlife species use the aquatic and terrestrial habitat in the project area including trumpeter swans, whooping cranes (listed as endangered by USFWS), moose, elk, mule deer, various fur bearers, and numerous small mammals.

4.0 FOUR ALTERNATIVES CONSIDERED

4.1 ALTERNATIVE 1—MULTIPLE AREA RESTORATION WITHIN 500-YEAR FLOODPLAIN

This alternative would involve studying and implementing a combination of environmental restoration measures at an unlimited number of areas throughout the entire 500-year floodplain of the Snake River from Moose to South Park Elk Feed Grounds, Wyoming, approximately 25 miles. Measures would be implemented, in a manner that would not reduce the base flood capacity, along non-leveed stretches, as well as leveed stretches, including areas between and outside of the levees.

The Corps identified a set of environmental restoration tools or measures best suited for the conditions occurring throughout the 500-year floodplain. These included: gravel removal; channel stabilization pools; secondary channels leading to and from off-channel pools; off-channel pools; spur dikes (bank barbs and kickers); eco fences (both rock and piling fences); anchored root wad logs; rock grade control structures; and head gates. Refer to paragraph 5.1 for a listing of the proposed tools. Spur dikes, eco fences, anchored root wad logs, and rock grade control structures would be designed to have multiple strengths based on the use of alternative materials. Material selection would be based on the level of strength determined appropriate to withstand 3 levels of major flow events: 15, 25, and 50 years. Table 4-1 provides a breakdown of the alternative materials that would provide different strengths for these structures. Rock gradations referenced in table 4-1 are based on minimum and maximum rock size for each gradation, ranging from the smallest for gradation 1 to the largest for gradation 4. When complete, the cost-benefit analysis being prepared (as part of the Feasibility Study for this environmental restoration project) will compare the cost of constructing tools of various strengths to the aquatic and terrestrial habitat benefits that may reasonably be expected to accrue for each level of tool strength. The results of the analysis would be used in selecting material strength or level of protection.

A plan for studying the feasibility of implementing this alternative was prepared and submitted to the local sponsor. The plan exceeded the practical acreage and the local sponsor rejected the plan due to cost, therefore, this alternative was eliminated from further consideration.

4.2 ALTERNATIVE 2—RESTORATION AT 12 AREAS WITHIN 500-YEAR FLOODPLAIN

This alternative is based on reduction of the "Alternative 1—Multiple Area Restoration Within 500-year Floodplain" to 12 specific areas. The same environmental restoration tools, as Alternative 1, would be implemented within these 12 areas, with the exception of head gates, which were eliminated from the range of tools due to expense. A plan for studying the feasibility of implementing this alternative, consistent with the environmental restoration project's purpose and

need, was prepared and submitted to the local sponsor. The cost of the study was significantly reduced, however, it was eliminated from further consideration because the magnitude and the acreage of this alternative was impractical at this time and the local sponsor rejected the plan.

4.3 ALTERNATIVE 3—RESTORATION AT FOUR AREAS WITHIN 500-YEAR FLOODPLAIN

This alternative is based on reducing "Alternative 2—Restoration at 12 areas within 500-Year Floodplain" to 4 specific areas (refer to section 5.0 for a description of areas) that provide the best opportunity for restoration of aquatic and terrestrial habitat. To determine the 4 most suitable sites, the 12 sites were evaluated on the basis of their institutional recognition (national laws and regulations specific to the area); public recognition (environmental and economic value); and technical recognition (importance of spring creeks, spawning habitat, and eagle nesting). Additional analysis included the potential for channel creation for fisheries restoration, riparian island preservation and restoration, fish habitat creation, and spring creek restoration. This multiple objective analysis (along with specific input from the scoping process, local input and considerations of property ownership, and cultural resources) served as the basis for selecting the four areas. Further discussion of evaluation criteria used in selecting the four sites may be found in the Jackson Hole, Wyoming, Environmental Restoration, Project Study Plan, July 1996. This alternative was determined to be financially feasible for the local sponsor and would still provide aquatic and terrestrial habitat benefits consistent with the environmental restoration project's purpose and need.

4.4 ALTERNATIVE 4—NO ACTION

If no environmental restoration measures are instituted, the main channel of the Snake River would continue to shift back and forth between the levees in a random manner. Based on current trends, much of the remaining mid-channel stands of mature trees would be washed away in Areas 9 and 10. Because the river does not occupy the entire area between the levees, there would be some recovery, particularly in the wider portions of the channel. Some damaged areas of the channel, over time, have recovered long enough to develop a 10- to 20-year growth. However, it does not appear that the river is stable enough to allow any significant areas to remain undisturbed long enough for a 50-year growth to occur. The leveed reach has experienced a net loss of bedload material. However, the rate of loss appears to be decreasing with time. Erosion and reworking of the channel bed gravel would continue in the future, but at a gradually decreasing rate. The continual reworking of the channel bed gravel would result in a progressive loss of fine material, which supports vegetation. Recovery of damaged areas would be slower and larger areas of the channel bed would remain relatively vegetation free.

Areas 1 and 4 are likely to retain a more natural, random distribution of vegetation than Areas 9 and 10 since there is more space for lateral channel movement.

Gravel transport and deposition in Areas 1 and 4 were probably the highest just after completion of the levees and has decreased (on the average) since then. For this reason, it is likely that most of the damage resulting from excess gravel inflow has already occurred. It is not likely that the gross area of denuded gravel beds would increase in these two areas. However, the continued inflow and deposition of gravel is likely to keep the channel unstable (particularly in Area 4 at the downstream end of the Federal Levee Project). The channel in this area is likely to continue shifting to one side or the other, attacking new undisturbed banklines on the margins of the meander belt, frequently damaging vegetation, and preventing the establishment of mature stands of cottonwood and willow. Based on these observed general trends, if no action is taken, the physical character of the river system would continue to experience similar changes. These changes would reasonably result in the progressive loss of portions of the remaining aquatic and terrestrial habitat and interfere with the development of mature stands of cottonwood and willow. Recovery of impacted areas would generally continue to be limited by the shifting, unstable nature of the channel. Overall, a general decrease in the amount of aquatic and terrestrial habitat would continue.

Table 4-1. Optional Structure Strengths for 15-, 25-, and 50-Year Major Flow Events.

Level of Protection	Piling Eco Fence	Rock Eco Fence	Bank Barb	Kicker	Anchored Root Wad Log	Rock Grade Control
15 years	6-inch pipe casing	No Alternative	Rock Gradation 1	No Alternative	1/4-inch cable	Rock Gradation 1
25 years	8-inch pipe casing	No Alternative	Rock Gradation 2	No Alternative	1/4-inch cable	Rock Gradation 2
50 years	10-inch pipe casing	No Alternative	Rock Gradation 3	No Alternative	5/16-inch cable	Rock Gradation 3
50 years	No Alternative	Rock Gradation 4	No Alternative	Rock Gradation 4	5/16-inch cable	Rock Gradation 4

5.0 PREFERRED ALTERNATIVE

"Alternative 3-Restoration at Four Areas Within the 500-Year Floodplain" was selected as the preferred alternative. The four selected sites in Teton County, Wyoming, are identified as Areas 1, 4, 9, and 10, as depicted on plates 2, 3, 4, and 5, respectively. Area 1 is located in sections 13, 14, 23, and 24, Township 40 N., Range 117 W.; Area 4 is located in sections 2, 3, 10, and 11, Township 40 N., Range 117 W.; Area 9 is located in sections 13, and 24, Township 41 N., Range 117 W.; and Area 10 is located in sections 5, 6, and 7, Township 41 N., Range 117 W., Teton County, Wyoming.

5.1 DESCRIPTION OF THE PREFERRED ALTERNATIVE

The environmental restoration project would involve gravel removal and construction of channel stabilization pools; secondary channels leading to and from off-channel pools; off-channel pools; spur dikes (bank barbs and kickers); eco fences (both rock and piling fences); anchored root wad logs; and rock grade control structures. (For detailed tool descriptions, refer to paragraphs 5.1.1 to 5.1.9.) Head gates were eliminated as a restoration tool due to expense. The proposed tools would be used in various combinations within each of the four areas.

The environmental restoration measures were carefully sited and hydraulically analyzed with provision for the effects of structures and projected vegetation growth to assure that they would have no adverse impact on the flood control functions of adjacent levee projects. In fact, the environmental restoration measures were designed to stabilize the channel in areas where it approaches the levee, and to shift the channel away from the levees or eroding bank in other areas. Stabilizing the channel and shifting the channel away from the levees should reduce the potential for the river to affect the levees and potentially result in reduced maintenance and associated costs. Typical examples are in Areas 1 and 10 where eco fence groups were strategically placed in a manner as to restore a cushion of riparian vegetation between the main channel and the adjacent levees or eroding banklines.

Temporary water diversions or berms would be necessary at some locations to de-water gravel removal sites. Water diversion materials would be excavated from dry adjacent cobble, gravel, and sand deposits. The berms would be used to alternately de-water braided channels (to allow the channel capacity excavations to occur in non-flowing waters) and portions of channels to allow work (to occur outside of the flowing water). Following completion of work in the area de-watered by the berm, the berm material would be scooped and transported from the site for upland disposal.

Construction is dependent upon local sponsorship. The local sponsor would provide real estate easements and cost share 35 percent of the construction cost. The Corps is hopeful that construction can begin in 2001 and end in 2004. However,

compliance with this schedule would be contingent upon the sponsor's participation. Construction would occur during low-flow conditions and would generally be limited to only one of the four areas each year.

The following tools have been identified for use in conditions occurring throughout the 500-year floodplain:

5.1.1 Gravel Removal

Gravel removal would be used to varying degrees in the implementation of the various environmental restoration tools to provide more channel stability and provide sediment deposition in controlled areas. Principally gravel removal would be used to improve fish habitat, compensate for reductions in channel capacity, increase channel stability, and improve sediment transport. Gravel removal would be used to construct channel stabilization pools, secondary channels, and off-channel pools. All gravel removal would be accomplished using a track-mounted excavator, rubber-tired backhoe, or other similar equipment (along with trucks to transport the material to disposal and stockpile sites).

Areas (from which gravel is removed to maintain channel capacity and to construct channel stabilization pools and off-channel pools) would be rearmored on the bottom surface using cobbles screened from the excavated material. Gravels, which are removed, would be either transported to a site located between the levees for screening or would be transported as unscreened material to an existing gravel processing facility off-site. Screening would separate out cobbles 4-inch plus in diameter or larger for use as armoring material. It may be necessary to temporarily stockpile the screened material. The 4-inch minus material would be transported from the screening location by truck for off-site upland disposal prior to anticipated high flows. The 4-inch plus cobble would be transported by dump truck from the screening site to the channel capacity, side pool, and channel stabilization pool excavation sites and placed to rearmor the disturbed bed. The material would be dumped in wind-row fashion, perpendicular to the normal stream flow to allow subsequent high flows to naturally disperse the material. The 4-inch plus cobble would be placed prior to anticipated high flows.

5.1.2 Channel Capacity Excavations

Channel capacity excavation would be used to offset reductions resulting from construction of the environmental restoration tools and effects of the tools upon channel structure and function. Additionally, channel capacity excavation would compensate for ongoing channel aggradation and loss of channel capacity. Channel capacity would be reduced by the installation of anchored root wad logs; discharge of riprap to construct rock eco fences, spur dikes, and rock grade control; and from the deposition of bedload material and resultant regeneration of vegetation. Bedload deposition would be intentionally triggered by structures such as the eco fences and anchored root wad logs. Channel capacity excavations would be necessary to

compensate for the effects of the environmental restoration project and maintain the 100-year base flow for flood protection.

Gravel would be removed from specific areas of the channel to compensate for the decreases in channel capacity. Gravel would be removed within the general vicinity of the areas identified on plates 2, 3, 4, 5, and 6.

5.1.3 Channel Stabilization Pools

Channel stabilization pools reduce flow velocity, catch bedload material, and reduce the transport of bedload material to downstream areas, which may already have an over abundance of material. These functions improve channel stability and improve fish habitat through the creation of a large pool. Channel stabilization pools would be excavated in strategically selected locations to trigger the deposition of bedload material and sediments. See plates 2, 3, 5, and 6 for approximate locations.

5.1.4 Secondary Channels

Secondary channels, also referred to as supply channels, are typically smaller channels, which parallel the main river channel. Secondary channels vary in size and depth and may carry flows year-round or only during periods of high water. These channels help disperse flows and suspended sediments throughout the floodplain and provide valuable aquatic habitat.

Secondary channels would be constructed in selected locations to improve flows to existing off-channel pools or provide flows to newly constructed pools. See paragraph 5.1.5 for discussion of off-channel pools. Some secondary channels exist within the leveed sections of the river. However, because of accelerated flows, the channels are degraded or plugged. Gravel and cobble would be excavated to either enhance existing secondary channels or to construct new channels. See plates 2, 3, 4, 5, and 6 for approximate secondary channel locations and typical design.

Because of the remote locations and potential disturbances to wetland and riparian vegetation by trucks accessing the excavation sites, dredged cobble, gravel, and sand would either be scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. The determination of whether to side-cast material or transport it from the site would be based upon the potential impacts of ingress and egress of trucks to the site. If dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Excavated gravel and cobble may be screened, depending upon the proximity of the site to the gravel screening area and anticipated need for 4-inch plus cobbles to rearmor excavation sites. Side-cast material would be uniformly spread on adjacent unvegetated gravel deposits below the ordinary high water mark (OHWM), in the dry and above the low flow of the river. Fine sediments such

as silts, sands, and soils would be placed in locations to promote riparian habitat restoration.

5.1.5 Off-Channel Pools

Off-channel pools provide important spawning and rearing habitat for cutthroat trout. Access to potential spawning areas in spring creeks and secondary channels and pools has been severely reduced by construction of the levees. This lack of adequate spawning habitat is considered a major limiting factor for cutthroat trout in the Snake River.

Off-channel pools would be constructed within the alignment of the secondary channels to provide rearing habitat for cutthroat trout. See plates 2, 3, 4, 5, and 6 for approximate locations and typical design. Some existing pools would be used and may only require limited excavation to enhance their function. Other pools would require complete excavation.

Excavated cobble, gravel, and sand would be either scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. Depending upon the proximity of the site to the gravel screening area and anticipated need for 4-inch plus cobbles, the excavated gravel may be screened. Side-cast material would be uniformly spread. Side-casting would occur below the OHWM, in the dry, and above the low flow of the river. The determination of whether to side-cast material or transport it from the site would be based upon the potential impacts of ingress and egress of trucks to the site and the opportunity to enhance riparian habitat as described above. If dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal.

5.1.6 Spur Dikes

Spur dikes would provide areas of resting habitat close to areas of high velocity, which may transport high quantities of aquatic insects used as food by cutthroat trout and other species and provide protection against bank erosion. Spur dikes would be installed in areas where stream velocity is normally too high for fish to spend much time. These resting areas may be further enhanced with the incorporation of large-woody debris on the downstream side. The large-woody debris would be placed in areas of ineffective flow.

Spur dikes consist of a series of either kickers or bank barbs extending into the channel from the adjoining levee. See plates 2, 3, 5, and 9. Riprap used to construct the spur dikes would consist of large angular rock, free of fines. It is likely that spur dike construction would require in-water work. Both kickers and bank barbs would be composed of riprap armor. Kickers may extend as much as 60 feet from the levee. Random fill excavated to embed the kickers would be used as the core material. Equipment used to excavate for the kickers and to place riprap would

sit atop the levee and would maneuver onto the top of kickers, when necessary. Bank barbs, which are smaller than kickers, would extend up to 30 feet into the channel from the levee. Both type of structures would be embedded into the levee.

Photo 5-1. Bank Barb.

5.1.7 Eco Fences

Eco fences block, slow down, or deflect the force of the current during high-flow periods in order to protect existing islands and vegetation and to cause deposition of sediment where new vegetation may become established. Eco fences will allow the river to heal itself. Rather than the costly and disruptive process of placing sediments with heavy equipment, the river will be allowed to do the work through a natural process. See plates 2, 3, 4, and 5 for general eco fence locations. Eco fences would be placed at the front and sides of existing wooded islands to prevent/inhibit further soil and vegetation loss or placed in areas where soil and vegetation have already been lost to facilitate deposition and vegetation regrowth. As vegetation becomes established, it will further slow flow velocities and encourage accelerated sedimentation. Indirect aquatic habitat benefits would be gained as vegetation is reestablished. As the amount of vegetation increases, shade and material (such as leaves and insects that fall into the river, providing nutrients to river

organisms) would also increase while ensuring the future availability of large-woody debris input to the river.

Two different types of fences: piling eco fences (see photo 5-2, below) and rock eco fences, may be used. See plate 8 for detailed drawings. Piles would be driven and have interconnecting cables attached. Rock eco fences, constructed of riprap, would require excavation to key the structure into the cobble, gravel, and sand substrate. Excavated material would be scooped and transported off-site for upland disposal. Riprap would be trucked to the site and dumped directly into the excavation site. Riprap used to construct the rock eco fences will be large, angular rock, free of fine sediment.

Photo 5-2. Piling Eco Fence, with Accumulated Woody Debris.

5.1.8 Anchored Root Wad Logs

Anchored root wad logs consist of tree trunks with the root attached. Depending on placement, anchored root wad logs may provide additional resting habitat for cutthroat trout and other fish species. The 1989 Jackson Hole Debris Clearance Environmental Assessment found that, "local scour and fill is also evident adjacent to woody debris left in the channel following the 1986 flood." Anchored woody debris

may also encourage sediment deposition and help establish new vegetation (see photo 5-2).

Anchored root wad logs would be obtained from along the river channel within the four project areas or from commercial sources. Logs would be transported to the installation site by either truck, rubber-tired skidder, or helicopter. See plates 2, 3, 4, and 5 for approximate locations. A backhoe may be used to level an area to place the logs so that the logs would have uniform bearing along the trunk and its root would be partially embedded. The logs would be fastened down with toggle bolt anchors. The anchors would be driven into the ground with a jackhammer and a jack would be used to pull up on the anchors locking them into place. The cable would be tied around the logs and cinched down to tighten the logs to the ground. (See photo 5-3.)

Photo 5-3. Naturally occurring root wad logs and accumulated organic matter (woody debris). This would be replicated by anchoring root wad logs. During periods of high flows the anchored logs would trap smaller woody debris.

5.1.9 Rock Grade Control

Rock grade control structures keep the river from eroding and destroying existing riparian areas. Riprap would be placed at specific areas where down-cutting of the

channel threatens channel stability. Existing cobble, gravel, and sand would be removed to a standard uniform depth of 3 feet below the ground surface. See plates 4 and 9. The material would be scooped and transported off-site for upland disposal. This area would then be graded and refilled with riprap to match existing topography. Riprap would be transported to the site by truck, dumped, and spread using the anchore track-mounted excavator. Riprap used to construct the rock grade control would be large-angular rock, free of fine sediments.

5.2 MONITORING AND MAINTENANCE

Monitoring would be conducted during construction to ensure compliance with various requirements identified in the Biological Assessment (BA) (appendix A) and the Fish and Wildlife Coordination Act Report (CAR) (appendix B). Monitoring would also be conducted following completion of construction to assess changes to aquatic and terrestrial habitat; to identify effects of river flows on the structures, as well as effects of the structures on the river; and to identify the need for structure maintenance. Monitoring procedures for structure integrity and function and for aquatic and terrestrial habitat changes would be identified in a monitoring plan that would be developed prior to completion of the Jackson Hole, Wyoming, Environmental Restoration Project. The monitoring plan would be coordinated with the local sponsor and appropriate resource agencies prior to finalization. The local sponsor would monitor and maintain the environmental restoration measures.

During the first few years of use, an elevated level of maintenance may be necessary until information is gathered that may identify more efficient uses of structures. Certain structures are likely to require maintenance to ensure they continue to function as designed. The shifting nature of the braided river is expected to have some effect upon the structures; however, the extent of effects would vary between structures and from site to site depending upon river conditions. Some structures may require only minor maintenance while others might require substantial reconstruction. The frequency with which maintenance may be necessary and the extent of necessary repairs would be dictated by the frequency and extent of river effects upon the structures. Maintenance would likely be necessary to maintain and ensure the proper function of eco fences, secondary channels, channel stabilization pools, spur dikes, and off-channel pools. Maintenance is not expected to be necessary on the remaining environmental restoration tools; however, monitoring would be necessary to assess the need for maintenance.

It is unlikely that vegetative growth from the environmental restoration project will adversely impact flood control. The channel typically has adequate room to adjust its location and conveyance. This is particularly true if the channel alignment is stabilized and excessive erosion is reduced. The designated mid-channel pool areas will provide a means of maintaining adequate conveyance by removing excessive gravel before it has an opportunity to build up in the channel. However, it will be important to assure that “maintenance” does not involve activities that

progressively increase the cross-sectional area of protected vegetation at any point along the channel beyond that indicated in the original design drawings.

Maintenance of environmental restoration tools would be conducted in accordance with the limitations and restrictions of the EA and its appendixes. The local sponsor would be responsible for acquiring permits necessary to implement maintenance.

Monitoring and repairing of Jackson Hole Flood Control Project access roads and levees (affected by construction and subsequent maintenance activities) are discussed in paragraph 6.6 Transportation.

5.2.1 Channel Stabilization Pools

The quantity of sediment being transported downstream cannot be precisely calculated and is expected to vary from year to year. Because of this, the optimum size of channel stabilization pools, and their anticipated effectiveness, is not known. Removal of gravel from channel stabilization pools, to maintain channel stabilization pools, would generally occur when one-half or more of the original channel stabilization pool gravel volume is refilled. Only about 50 percent of the original trap area would need to be disturbed to remove the quantity necessary to maintain the trap. Excavation would not vary from or exceed the original trap design. The traps would have to be closely monitored to ensure excessive excavation does not occur. Under average conditions, several years may be necessary to fill the traps; however, it is possible that a single flood event could fill the traps completely. Experience over time will determine the appropriate level of maintenance.

5.2.2 Secondary Channels

The deposit of gravel and subsequent blockage of the upper end of the channel would necessitate maintenance. If groundwater is inadequate, the secondary channels would need to be reopened to provide an adequate inflow of water for the downstream pools. Gravel blockages would be excavated sufficiently to provide 2 to 3 cubic feet per second (cfs) flow. Excavated gravel would be side-cast due to the anticipated small quantity.

5.2.3 Off-Channel Pools

Off-channel pools would be subject to refilling during high-flow seasons. Pools that are close to the main channel could be refilled with gravel and cobbles in a single high-flow season. Those farther away would likely last a number of years, refilling with silt and sand brought in by the interconnecting channels and by general over-bank flow during high-flow periods. Due to the braided nature of the river, it is nearly impossible to select locations where pools would always be protected from potential destruction by major flood flows or channel changes. Based on this, various approaches to maintaining off-channel pools would be used.

Pools near the margins of the active meander belt would be allowed to fill completely. A new pool would then be constructed nearby, without disturbing the old pool or its water supply. Where possible, the new pools would be built either upstream or downstream of the existing pools in order to use the same supply channels. Pools constructed near the main channel in the vegetation-free areas of the channel would be reexcavated only when completely filled with gravel. These channels could be filled in completely during a major event, which could also involve major changes in the main channel. The main channel may even cut a course through the center of a pool. In the latter case, the pool would be reexcavated at another location (probably along the previously abandoned channel). The objective would be to approximately maintain the same area of pools throughout the life of the environmental restoration project either by reexcavation at the same location or relocation of a pool to a more advantageous site. Maintenance would be performed during the low-flow period.

5.2.4 Spur Dikes

Spur dikes would occasionally be damaged by high flows. Measurements, taken at various locations on the existing channel, indicate that erosion can extend down to at least 15 feet below the high-water level. The mode of damage most likely to occur would be undercutting of the toe of the dike and collapse of material into the void with material being transported downstream. Maintenance of bank barbs or kickers would generally involve reestablishment of the toe and restoration to the original geometric outline. Maintenance could include placement of additional bank or toe protection, strategic placement of boulders or intermediate barbs to break up the undesirable flow pattern if undesirable flow patterns are created. In a worst-case scenario, the spur dike group can be removed. It is anticipated that a staged construction sequence will allow design adjustments to be made as experience is gained from the performance of these structures.

5.2.5 Eco Fences

Maintenance measures for the eco fences should provide for minimal adjustment of fence lengths or alignment, repair of damaged cables or piling, and reestablishment of the fence tie-off to the bankline if erosion damage threatens to destroy the function of the fence, increase bank erosion, or threaten adjacent flood control structures. This could involve removal of some portions of fence if it proved to be poorly aligned or improperly located.

Maintenance would most likely be necessitated by failed posts and fencing or by erosion around the landward end of the fence. Repair would involve reestablishment of the fence tie-off by extending the fence back to the undisturbed bankline. Repairs may include repositioning existing piles and cable, installing longer posts, reattaching the cables, or adding other material to trap debris. In some cases, it might be sufficient to drive and attach additional supporting posts in

locations where the fence is beginning to sag or fail. Work would be done during low flows.

Depending upon how the river affects the fence site, maintenance work may or may not occur in the water. If a fence is failing to catch debris, trapping efficiency might be increased by adding a finer mesh screen that would capture smaller debris, or exposed areas may be covered by dragging some of the debris over to places where it is deficient. If debris is failing to be trapped or is being deflected around the fence, it may be necessary to add one or more fence panels oriented upstream near the end of each fence. In some areas, adjustments in the location or angle of eco fences may be needed if the river abandons the channel.

6.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

6.1 WATER

The Snake River and its tributaries in the upper Snake River Basin have regular patterns of natural seasonal flow with high flows during the months of May through July, receding flows in August and September, and low flows in the months of October through April. High flows in the late spring and early summer result from melting of the winter-accumulated snow pack, sometimes augmented by rain storms. Winter flooding due to thawing conditions and rain-on-snow conditions can occur but rarely result in damaging flows. For the period of record, maximum annual peak discharges have always coincided with the spring snowmelt season. Total annual runoffs for a given area vary with the amounts of precipitation received during the snow pack accumulation and the snowmelt seasons.

The porous and unconsolidated alluvial and glacial deposits in the valley are the major aquifers in Teton County. Much of the floodplain is close to the level of the river and laced with abandoned or relief channels. Due to the ready exchange of water between the river and the aquifer, channels that are abandoned or cutoff by levees often still contain flowing or standing water. Along the Snake River and its major tributaries, the aquifer can supply very large amounts of water. Water tables are often less than 5 feet below the ground surface for a significant portion of the year. Groundwater levels, reflecting the surface runoff patterns, are highest in the spring and early summer and lowest later in the fall and early winter. Spring-fed watercourses will rise in tandem with the snowmelt runoff in the main streams, but the increase in flow is of a much lesser magnitude and does not seem to approach damaging levels.

Numerous irrigated diversions remove water from the Snake River. The irrigation season generally lasts from about May 1 to October 1. There are currently eight active diversions within the Federal Levee Project area and an additional eight inactive diversions. Regulation by the use of storage space in Jackson Lake reduces the Snake River flow during October through May, or early June, and augments Snake River natural flows during July, August, and September in order to satisfy downstream irrigation requirements.

6.1.1 Opportunities for Water Flow Regulation Using Jackson Lake.

Changes in the operation of Jackson Lake could improve fish habitat and/or reduce erosion in the Snake River. Such changes might include regulation of peak flows and summer releases and regulation to augment minimum flows.

6.1.1.1 Regulation of Peak Flows and Summer Releases.

Between 1917 and 1956, Jackson Lake was regulated primarily in the interest of irrigation storage, with only incidental flood control benefits. These operational policies resulted in an average reduction in the annual unregulated peak discharges of about 4,600 cfs. Because the reservoir was occasionally refilled prior to the occurrence of the actual flood peak, in some years no significant control was achieved. During some low water years, the high summer irrigation releases exceeded the natural peak inflow. In addition, sustained high flows, at or near bankfull, were blamed for increased bank erosion in unleveed reaches of the river. In the 1940's, local interests began pressing for changes in the operation of Jackson Dam that would address the problem of local bank erosion. With the construction of Palisades Dam, up to 350,000 acre-feet of flood control space (25 percent of the total 1,400,000 acre-feet available in Palisades Reservoir) was made available for use in Jackson Lake operational plans.

The formal implementation of this provision went into effect in 1956 when the Palisades Water Control Manual was published. The primary objective of the provision was to limit flows to a maximum of 20,000 cfs below Palisades Dam while providing significant, but less reliable, control upstream. Typically, the Bureau of Reclamation evacuates a minimum of 200,000 acre-feet of space from Jackson Lake with releases that may be higher than inflow during the irrigation season. Additional space can be evacuated depending on runoff forecasts prior to May 1. If the reservoir has been drawn down below the minimum flood control space on October 1, this deficit may be recovered by gradually refilling during the winter. An attempt is made to limit releases to the 5,000 to 7,000 cfs range during the peak runoff period, although these may be reduced as necessary in an attempt to limit peak flows at the Flat Creek gage to 20,000 cfs. During the period 1956 to 1986, Jackson Lake regulation achieved an average reduction in the annual peak flow at the Wilson gage of 6,200 cfs, compared to 4,600 cfs prior to 1956. In the years since 1956, regulated peak flows at the Wilson gage have exceeded 20,000 cfs 4 times (in 1982, 1986, 1996, and 1997) compared to 12 times prior to 1956. However, of the 12 times prior to 1956, only 1 (in 1943) occurred during the period 1930 to 1956. The remaining 11 occurred prior to 1930.

Although flood control regulation has been improved by Jackson Lake operations, sustained, near bankfull flows in the Jackson Hole area (about 10,000 cfs) probably continue to contribute to bank erosion problems in the area outside the Federal levee reach. Based on records from the two U.S. Geological Service (USGS) gages, the Snake River near Wilson and below Flat Creek (from 1973 to 1986) sustained flows exceeding 11,000 cfs occurred an average of 4 weeks each year.

Flood control regulation between Jackson Lake and Palisades Reservoir has been less than optimum due to the high priorities placed on irrigation storage at Jackson Lake and the emphasis on flood control below Palisades Dam. But, unless major changes are made in Congressional authorizations for the Jackson-Palisades

system and in current irrigation contracts and interstate compacts, any improvements arising from new studies would likely be marginal. The potential for peak flow reduction downstream of the Jackson Dam project is also limited by the fact that only about 38 percent of the Snake River runoff at the Flat Creek gage is controlled by Jackson Lake. To significantly improve the opportunity for peak flow reduction would require construction of additional upstream storage facilities.

6.1.1.2 Regulation for Minimum Flow Augmentation.

Jackson Hole is a recreational haven for thousands of visitors each year. Recreational fisheries are an important element in the all-season attraction of the region. Reservoir levels at Jackson Lake have been regulated to maintain optimum breeding and nursery conditions. This has usually meant holding the pool elevation constant from October 1 (the end of irrigation season and approximately the middle of Mackinaw egg-laying season) until the eggs hatch in the spring.

However, recognizing cutthroat trout as an important resource, fisheries managers have determined that a minimum stream flow of 280 cfs from Jackson Lake is required to support a healthy population of cutthroat trout. The optimum flow is 400 cfs, and flows above 600 cfs should be avoided. To implement this plan, the lake could be drawn down as much as 5 feet after October 1 to maintain stream flows below the dam. There is an attempt to meet the 280 cfs minimum but no formal minimum release requirement. The Bureau of Reclamation, *Operations Manual*, December 1997, states in part: "If the reservoir was drawn down to the minimum flood control space on October 1, then the release is set to match inflow. If the reservoir was drawn down below the minimum flood control space on October 1, then the release can be set to a minimum inflow or 280 cfs whichever is less. The release selected will allow the reservoir to either refill to the minimum flood control space gradually over the winter or refill as much as possible up to the minimum flood control space."

Without Jackson Lake Dam, flows would have dipped below 400 cfs in each of the last 87 years and dropped below 280 cfs in 74 of those years. Statistically, stream flows have been less than 400 cfs 21.1 percent of the time and less than 280 cfs for 5.5 percent of the time.

With Jackson Lake Dam in place, there were 9 years since 1909 with average annual flows less than 1,000 cfs. The lowest average annual flow year was 1977 with an average annual flow of 660 cfs. If flows above 4,000 cfs are excluded because they occurred during floods and may not have been held by a moderate size dam, then there were 15 years with average annual flows less than 1,000 cfs. Of these, six occurred as back-to-back pairs. Again, the lowest average annual flow was 660 cfs in 1977.

During the construction of Palisades Dam in 1956, the Corps negotiated 800,000 acre-feet of nonexclusive flood control storage at the 2 projects with 25 percent

coming from Jackson Lake and 75 percent coming from Palisades Dam. The agreement requires the Bureau of Reclamation to make the storage available between March 1 and May 1 each year unless the Corps and Bureau of Reclamation agree in advance that expected spring runoff would be better controlled by different operation.

Although snow melt forecasting has come a long way, the exact timing and quantity of runoff is still subject to considerable error. The 1997 spring runoff was nearly 50 percent greater than anticipated, forcing both dams into defensive operation and causing severe flooding downstream.

For the current study, a representative sample of flow periods was selected that reflect current operating needs of downstream irrigators as interpreted by the Bureau of Reclamation Reservoir Operations Center. Both 1992 and 1994 were classic low-flow years. The 5-year period extending from October 1991 through September 1996 appeared to provide a full range of possibilities including the two drought years of 1992 and 1994, as well as an unusually high runoff year in 1996. This period was selected for further detailed analysis.

Table 6-1 is a list of "natural" (flows assuming no Jackson Lake regulation) Snake River flows at the Jackson-Wilson Bridge ranked by peak flow and volume:

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge.

Ranking by Peak		Ranking by Volume	
Date	Discharge (cfs)	Date	Volume (kaf[1/])
06 06 97	34,120	06 06 97	3,970
06 02 86	32,520	06 24 71	3,565
06 16 74	30,540	06 10 96	3,414
06 13 18	30,230	06 29 82	3,369
06 10 96	30,090	06 02 86	3,297
06 24 71	28,170	06 02 56	3,248
06 02 56	27,550	06 16 74	3,235
06 09 81	27,530	06 21 43	3,233
06 29 82	26,070	06 09 72	3,230
06 09 72	25,590	05 26 13	3,205
06 20 17	24,790	06 13 18	3,176
05 21 54	24,430	06 14 27	3,155
05 27 28	24,240	06 13 65	3,149
06 08 12	23,420	05 27 28	3,087
06 06 57	23,330	06 06 76	3,062
06 14 27	23,260	06 20 17	3,057
06 13 65	23,210	05 21 25	2,962

[1/] 1,000 acre-feet.

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge (continued).

Ranking by Peak		Ranking by Volume	
Date	Discharge (cfs)	Date	Volume (kaf)
05 26 13	22,060	06 08 12	2.952
06 09 89	22,060	05 29 51	2,938
05 29 51	21,930	06 16 11	2,906
06 06 95	21,670	06 17 16	2,899
05 22 93	21,670	06 10 78	2,879
06 06 76	21,450	06 01 84	2,841
06 16 11	21,380	06 05 14	2,826
06 06 52	20,800	06 11 21	2,807
06 10 78	20,530	06 11 83	2,799
06 01 84	20,520	06 07 50	2,764
06 14 53	20,480	06 06 95	2,703
06 07 50	20,350	06 13 62	2,683
06 17 16	20,290	06 06 52	2,640
06 09 70	20,230	06 06 57	2,619
05 21 25	20,120	07 04 75	2,614
06 03 48	20,020	05 21 54	2,595
06 21 43	19,980	05 15 36	2,594
05 15 36	19,850	06 07 22	2,546
06 15 59	19,790	06 07 38	2,545
05 24 80	19,480	05 10 47	2,539
05 28 79	19,260	06 21 67	2,535
05 28 79	19,260	06 21 67	2,535
06 07 38	19,160	06 09 20	2,487
06 11 21	19,130	06 09 70	2,447
06 11 83	19,020	06 07 64	2,426
07 04 75	18,970	05 25 23	2,410
06 15 63	18,900	06 09 89	2,399
06 21 67	18,350	05 27 69	2,394
06 05 91	18,120	06 06 46	2,394
06 05 14	18,020	05 22 93	2,382
06 09 20	18,010	06 12 49	2,371
05 25 58	17,960	06 13 68	2,331
06 07 64	17,930	05 21 32	2,311
06 07 22	17,890	06 03 48	2,279
06 13 35	17,330	05 24 80	2,272
06 13 33	16,650	06 05 91	2,250
06 06 46	16,520	05 28 79	2,240
06 12 49	16,430	05 27 85	2,203
05 25 23	16,380	06 15 63	2,169
06 13 68	16,320	06 15 59	2,149
05 27 69	16,210	06 14 53	2,137

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge (continued).

Ranking by Peak		Ranking by Volume	
Date	Discharge (cfs)	Date	Volume (kaf)
05 21 32	15,960	05 17 39	2,113
06 13 62	15,720	06 09 42	2,106
05 10 47	15,710	06 25 45	2,103
06 13 55	15,490	05 24 29	2,092
06 25 45	15,460	06 09 81	2,073
05 27 61	15,390	06 13 35	2,065
05 27 85	15,010	06 13 33	2,044
05 31 66	14,990	05 30 30	2,031
05 21 73	14,820	06 11 90	2,028
06 09 42	14,350	05 31 66	2,017
05 28 37	14,270	06 13 55	1,975
05 13 94	14,190	05 21 73	1,952
05 24 29	13,730	06 02 44	1,935
06 11 90	13,420	06 01 15	1,917
06 03 60	13,300	05 28 37	1,900
05 28 88	12,590	05 24 26	1,882
05 30 30	12,370	05 28 19	1,851
05 28 19	12,330	05 25 58	1,821
05 17 39	11,120	05 26 41	1,818
05 26 40	11,080	05 27 61	1,806
05 26 41	10,880	06 03 60	1,805
05 18 24	10,780	05 19 87	1,780
06 01 15	10,620	05 26 40	1,733
06 02 44	10,390	05 18 24	1,707
05 24 26	10,290	05 13 94	1,642
05 08 92	9,870	05 08 92	1,640
05 19 87	9,700	05 28 88	1,617
06 09 77	8,820	06 02 31	1,433
05 07 34	8,690	05 07 34	1,399
06 02 31	8,610	06 09 77	1,328

Assuming reasonable forecasting, volume becomes a more important indicator of low-flow capability than peak flow. Not surprisingly, irrigation demands are higher in low-flow years than in normal years due to dry conditions everywhere else in the basin. The basin runoff volume for 1994 was the sixth lowest flow on record and in 1992 was the fifth lowest flow on record. The 1994 volume record was chosen as the test case for low-flow discharge because it is recent in history and had a very low flow. Irrigation demands in 1992 were considered too extreme for the present analysis.

The 1994 hydrograph of mean daily flows indicated the summer runoff of July subsided into the irrigation demand curve of August. The 1994 irrigation demand

was then superimposed on the 5-year test period from October 1, 1991, to December 12, 1996, to determine if optimum low flows could be maintained.

The U.S. Army Hydrologic Engineering Center's (HEC) model HEC-5. "Simulation of Flood Control and Conservation Systems," was used to route the flows through Jackson Lake. The following four criteria were used for annual flow routing:

- maintain a minimum flow of 400 cfs below the dam;
- maintain minimum irrigation flows at Jackson-Wilson Bridge equal to 1994;
- draw Jackson Lake down to elevation 6,755 by October 10; and
- do not exceed 15,000 cfs at Jackson-Wilson Bridge.

The 1994 irrigation demand curve was repeated during each year of the simulation. The simulated hydrograph indicated that a low flow of 400 cfs was maintained even during the two drought years of 1992 and 1994. This analysis indicated that the 400 cfs minimum could be maintained during the winter if irrigation demand was the same each year. In the draught year of 1992, the irrigation demand was considerably higher than normal, resulting in an October 1 pool level that was several feet lower than would normally occur at this time of the year. It was so low that it would not have been possible to refill the reservoir if 400 cfs had been released during the fall and winter months. Based on the analysis to date, it appears that the 400 cfs could be maintained during normal flow years, but that during drought years similar to 1992, this level of release could not be achieved while still meeting the irrigation demands for the following year. It should be emphasized that the Bureau of Reclamation operates Jackson Dam. They are in a better position to consider all of the operational constraints and should be the agency that makes the final determination whether additional winter-flow augmentation is possible.

6.2 AQUATIC ENVIRONMENT

A wide variety of aquatic organisms are located within the environmental restoration project boundaries. Construction and maintenance of the restoration can cause short-term adverse impacts to some of these organisms. The long-term positive benefits created through the successful environmental restoration project would far outweigh these short-term impacts. A period of several years between maintenance excavations would be desirable. This would help minimize recurring impacts to the aquatic environment. Impacts to various groups of organisms are discussed in the following sections.

6.2.1. Fish

6.2.1.1 Cutthroat Trout

Cutthroat trout are the main fish species of concern in the environmental restoration project area. The WGFD has designated the Snake River in the project area as a Class 1 or a blue ribbon trout stream. This indicates that the river is of national

importance as a trout stream and should receive high priority for protection (Kiefling 1978, Corps 1989). Cutthroat trout populations in the area are mainly limited by lack of adequate spawning areas. Access to spring creeks and side channels, which are used for spawning, has been severely reduced due to construction of flood control levees. In addition to access restrictions, flow patterns within spawning channels have been altered, which further reduces useable spawning habitat.

Spawning habitat is considered one of the major limiting factors for cutthroat trout (USFWS 1988, Erickson 1980, Corps 1989). Most cutthroat trout spawning occurs during March through June in the spring creeks that enter the river along the project reach (Kiefling 1978, Corps 1989). The openings of many of these spring creeks are currently blocked by levees. Spawning is limited or non existent in the Snake River because of several factors. These include spring flows carrying high bedloads, high turbidity, human-induced modifications of the channel, and a cobble substrate that is typically too large for cutthroat trout spawning (Kiefling 1978, Erickson 1980, USFWS 1988, Corps 1989).

Another factor limiting cutthroat trout populations is the lack of overwintering habitat. Results from an in-stream flow study conducted above the project reach of the Snake River suggests that low-flow overwintering habitat is limited (Annear 1989, Corps 1989). Aquatic habitat associated with pools with cover present is often more important during winter low-flow periods (Lestelle and Cederholm 1984, Murphy et al. 1984, Swales et al. 1986, Bustard and Narver 1975b, Corps 1989). In many areas, it has been shown that structures formed by large-woody debris contribute significantly to the total habitat in streams for cutthroat trout and salmon (Corps 1989). Because of a lack of slow, deep pools, or other flow diversions, low flows and ice formation in the winter can severely limit habitat useable by cutthroat trout during the winter. Lack of overwintering habitat appears to cause high mortality in young age classes of cutthroat trout in the Snake River system (Kiefling 1978).

Baseline cutthroat trout habitat data was measured in October 1998. Resting pool area for use by cutthroat trout during the winter was the main habitat type considered. Figure 6-1 shows that fish habitat would increase as soon as environmental restoration project in-stream structures are installed. Additional figures for each work area can be found in appendix C. There may be a further increase as riparian vegetation increases. The "with project" projections shown in Figure 6-1 are based on implementation of all proposed structures and environmental restoration tools. If no action is taken, fish habitat would decrease in the future. It is important that habitat data is collected at the same time of year annually for the best comparisons between years.

Figure 6-1. All Four Areas - Fish Habitat Unit Projections.

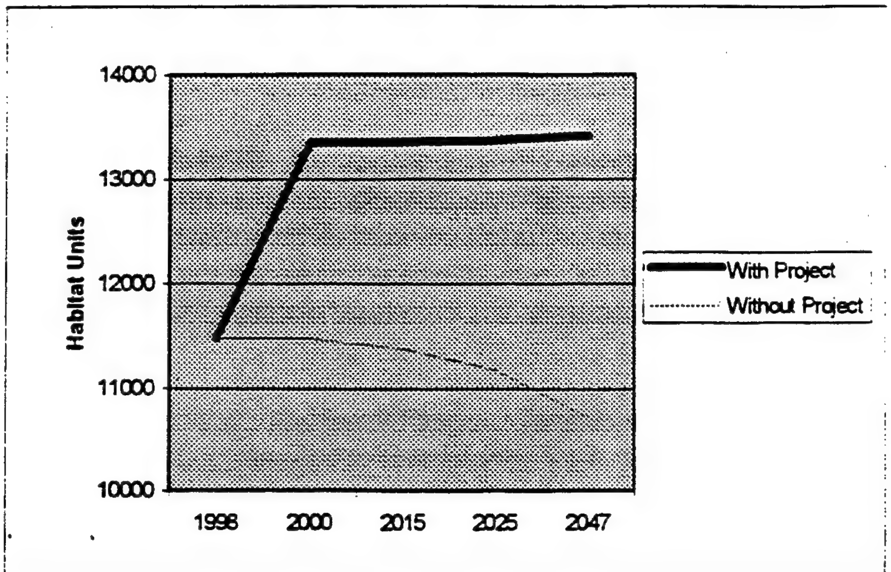

Table 6-2 lists the distribution of pool habitat type by area. There was an estimated 114,689 square feet of pool habitat in the evaluated sections of the areas.

Table 6-2. Square Feet of Pool Habitat Classes.

Area	Pool Class		Pool Area
1	3		1,076
	2		646
	1		9,903
		Total	**11,625**
4	3		23,412
	2		11,840
	1		11,087
		Total	**46,339**
9	3		1,830
	2		6,243
	1		15,070
		Total	**23,143**
10	3		4,305
	2		4,520
	1		24,757
		Total	**33,582**
	Grand Total		**114,689**

Pool class is important for determining the relative cutthroat trout habitat value for individual pool areas. Pools of different classes provide different amounts and quality of cover. Pool classes associated with the highest standing crops of cutthroat trout are assumed to be optimum. First class pools are large and deep. Pool depth and size are sufficient to provide a low velocity resting area for several

adult cutthroat trout. More than 30 percent of the pool bottom provides cover due to depth, surface turbulence, or the presence of structures (*e.g.*, logs, debris piles, boulders, or overhanging banks and vegetation). The greatest pool depth is greater than or equal to 6.6 feet deep in streams greater than 16.4 feet wide.

Second class pools have moderate size and depth. Pool depth and size are sufficient to provide a low velocity resting area for a few adult cutthroat trout. From 5 to 30 percent of the bottom provides cover due to surface turbulence, depth, or the presence of structures. Typical second class pools are large eddies behind boulders and low velocity, moderately deep areas beneath overhanging banks and vegetation.

Third class pools are small or shallow or both. Pool depth and size are sufficient to provide a low velocity resting area for one to very few adult cutthroat trout. Cover, if present, is in the form of shade, surface turbulence, or very limited structure. Typical third class pools are wide, shallow pool areas of streams or small eddies behind boulders. Virtually the entire bottom area can be seen (Hickman et al. 1982).

This environmental restoration project is designed to increase the amount of overwintering and rearing habitat available to cutthroat trout, as well as to protect existing riparian areas from frequent high-water events. Total pool area within the study reaches would increase. Class 1 and 2 pools would increase most and provide the greatest benefit. Simply improving overwintering and rearing habitat may not increase the cutthroat trout population. However, by increasing these types of habitat, more or healthier cutthroat trout may survive to spawn, which could increase the population. Protecting and reestablishing vegetation between the levees would also be a benefit by providing organic material to the stream. This organic material could be used directly by fish in the form of terrestrial insects or cover, or indirectly when bacteria colonize on the organic material and are eaten by aquatic invertebrates that are then eaten by fish.

In-water construction would temporarily displace cutthroat trout from a few hours to a few months. Cutthroat trout may move into construction areas such as spur dikes as soon as equipment leaves the area. However, they may not inhabit large gravel removal areas for up to a few months until aquatic invertebrates recolonize the area. The area of impact would be limited because most gravel removal would take place in areas above the low-flow channel. Construction of eco fences and anchored-woody debris would have little effect on cutthroat trout as long as there are no in-water discharges. Spur dikes would create areas of low velocity resting habitat that would be used by cutthroat trout. Environmental restoration tools that protect or reestablish vegetation between the levees would provide a long-term benefit for cutthroat trout. Maintenance on the environmental restoration tools would have effects similar to construction. The least amount of activity necessary to maintain the environmental restoration tools would cause the least amount of impacts.

6.2.1.2 Other Game Fish Species

Mountain whitefish (*Prosopium williamsoni*) are abundant in the Snake River. This species may compete with cutthroat trout for food, but only at a limited level in the Snake River (Kiefling 1978, Corps 1989). Other salmonids are present in the region, but in relatively low abundance. They include brook trout (*Savelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), lake trout (*Savelinus namaycuch*), and possibly grayling (*Thymallus arcticus*) (Kiefling 1978, USFWS 1988, Corps 1989).

An increased amount of overwintering habitat would also be used by these species. The overall population distribution is not expected to change. Construction, maintenance, and long-term effects for these game fish species would be similar to the effects on cutthroat trout.

6.2.1.3 Non-Game Fish Species

Suckers (Catostomids) are an important food source for bald eagles (USFWS 1988, Corps 1989). Sculpins (Cottids) are a major prey item for cutthroat trout (Kiefling 1978). Five species of minnows (Cyprinids) are present in the Snake River. These small fish may be used as prey by cutthroat trout (Kiefling 1978, Corps 1989).

Excavation within gravel removal areas may displace some non-game fish species. Some mortality on small fish is expected in areas of in-water excavation, such as sculpins and minnows that may hide in the substrate instead of leaving the area. It is not expected that this would have noticeable long-term population effects on these species. By creating temporary berms and working on dry gravel bars during low-flow periods, adverse effects would be minimized. Non-game fish may also avoid gravel removal areas until aquatic invertebrates recolonize the area.

If vegetation between the levees is dramatically increased and the amount of organic material in the river increases, it is possible populations of these species may increase, which could provide more food for species that prey on them. Maintenance would have effects similar to construction but be temporary and localized.

6.2.2 Aquatic Invertebrates

Aquatic invertebrates are a primary food source for all carnivorous fish in the Snake River. A variety of species are present. Kroger (1967) found that 98 percent of the sampled biomass was comprised of mayflies (Ephemeroptera), true flies (Diptera), caddisflies (Tricoptera), and stoneflies (Plecoptera). Four genera of caddisflies produce the highest biomass of insects in the Snake River. Kiefling (1978) found a similar composition and abundance in the Gros Ventre River.

Most aquatic invertebrates identified in the Snake River are herbivores and detritivores, although a few are carnivores (Kroger 1967). Of the six most abundant

species of caddisflies, three are herbivorous and three are carnivorous. The mayflies are predominately herbivorous. The stoneflies have the most varied diet. being both herbivorous and carnivorous. The true flies are generally herbivorous. Their larvae are an important food source to carnivorous invertebrates.

There may be a decrease in abundance of aquatic invertebrates in gravel removal areas due to excavation. However, this decrease is expected to be short-term. By working on dry gravel bars during low-flow periods, adverse effects would be minimized. Aquatic invertebrates should recolonize gravel removal areas within a few months. The species composition would depend on factors such as velocity, depth, and substrate size. Species composition may change in areas where structures are installed that change the flow conditions.

The overall abundance of aquatic invertebrates should not change noticeably until organic material input and entrapment in the stream increases. This could lead to an increase in the abundance of aquatic invertebrates.

Maintenance would have little effect on aquatic invertebrates except in-water excavations, which could cause temporary localized reductions in some species.

6.2.3 Aquatic Plants and Algae

True aquatic communities are supported by standing or flowing water year-round and are composed primarily of white buttercup (*Ranunculus aquatilis*), yellow buttercup (*R. cymbalarai*), speedwell (*Veronica americana*), waterweed (*Elodea* spp.), pondweed (*Potamogeton* spp.), watercress (*Rorippa nasturtium-aquaticum*), water milfoil (*Myriophyllum* spp.), mare's tail (*Hippuris*), and duckweed (*Lemna* spp.). White buttercup commonly forms large mats in shallow, standing water. Mat-forming algae is also common in shallow, stagnant ponds. Liverwort and stonewart species are also common.

The cobble-gravel bottom communities are dominated by foxtail (*Alopecurus aequalis*), silverberry (*Eleagnus commutata*), willow (*Salix* spp.), timothy (*Phleum pratense*), sedge (*Carex* spp.), muhly (*Muhlenbergia*), sweet clover (*Melilotus officinalis*), horsetail (*Equistum* spp.), and dock (*Rumex* spp.).

Some plants would be impacted during construction and maintenance. They may be run over by equipment or dug up in excavation areas. However, the plants growing in gravel removal areas would generally only survive until the next high flow. As an additional measure, access routes to construction sites would be selected to minimize impacts to existing plants.

Creation of shallow, low velocity pools may encourage the growth of some aquatic plants and algae. Species compositions would be determined by factors such as depth, velocity, and available nutrients. This increase would only be present until the areas refill with bedload. Debris fences, channel stabilization, and anchored

woody debris may provide enough protection to some areas to allow for longer survival of some plant species. This longer survival may provide bank stability and organic matter to the stream, as well as other environmental benefits. Maintenance impacts would be similar to initial construction impacts but be temporary and localized.

6.3 TERRESTRIAL ENVIRONMENT

This environmental restoration project, if implemented, would have great potential for improving the terrestrial habitat within the confines of the four areas. Habitat Evaluation Procedures (HEP) were used to determine the relative habitat values of the four sites. Habitat value is measured in relation to the wildlife species that derive benefit (*i.e.*, cover, food, water, nesting, *etc.*) from the habitat.

Yellow warbler and song sparrow were chosen as the two species that would use the majority of the shrubby/woody habitat associated with the upper Snake River floodplain. A yellow warbler likes medium-sized shrub habitat comprised primarily of coyote willow and other willow species along streams. This type of habitat is referred to as riparian or palustrine scrub-shrub (PSS). The song sparrow likes thick brushy areas and dense forbs near streams. The habitat is comprised of rose, berry vines, currant, and young poplar trees referred to as understory riparian or palustrine forest (PF). The habitat values or habitat suitability indexes (HSI) are obtained by measuring the environmental variables associated with each species.

The acreage for the two habitat types (PSS and PF) were obtained for each work area by mapping the covertypes from aerial photography. The years of photography used were 1956, 1991, and 1996. From the acreage figures derived from these sets of photography, HSI values were applied to each acre of habitat. For example, if the song sparrow has an HSI of 0.5, then the habitat units found on 50 acres of PF is 25. If a yellow warbler has an HSI of 0.4, then the number of habitat units found on 100 acres of PSS is 40. The HSI values are always a figure between 0 and 1.

The trend of the habitat unit increases with the environmental restoration project and decreases with out the project for both the yellow warbler (PSS) and song sparrow (PF). Future habitat value is based on an estimate of vegetative growth or degradation that could result if the project is implemented as planned or if the area is left as it is today. Figures for each work area can be found in appendix C.

As depicted in figures 6-2 and 6-3, there is great potential for terrestrial habitat improvement along the river corridor between the levees if the environmental restoration project is implemented as planned. If the project is not implemented, the riparian vegetation in the river corridor would continue to degrade.

6.3.1 Vegetation

The vegetation in the upper Snake River drainage near Jackson, Wyoming, is typical of the central Rocky Mountain region. Upland vegetation types in the area include: sagebrush-grassland, lodgepole pine/Douglas fir, and subalpine fir/Engleman spruce (Corps 1994). The sagebrush-grassland type occurs on the glacial outwash plains and terraces above the floodplain. This type is dominated by sagebrush (*Artemisia tridentata*) and perennial grasses, *e.g.*, wheatgrasses (*Agropyron* spp.); fescues (*Festuca* spp.); and bluegrasses (*Poa* spp.). Forests dominated by lodgepole pine (*Pinus contorta*) occur at lower elevations (6,300 to 7,800 feet) along rivers and above the glacial outwash plain. Douglas fir (*Psuedotsuga menziesii*) intermixes with lodgepole pine, but is generally dominant only on ridge tops and east-facing slopes. Subalpine fir (*Abies lasiocarpa*) and Engleman spruce (*Picea englemanii*) dominate higher elevation (7,800 to 10,000 feet) forests (Corps 1994).

The floodplain along the Snake River and its tributaries includes mixed deciduous/coniferous forests and wetlands. Floodplain forest consists of narrow-leaf cottonwood (*Populus angustifolia*) and willow (*Salix* spp.) intermixed with Engleman and blue spruce (*Picea pungens*). Wetlands occur where the water table is high enough to support hydrophytic plants (*i.e.*, plant species that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content). These include three major types: PSS, palustrine emergent, and aquatic bed (Corps 1994). The PSS wetlands are found primarily on stable gravel bars and dikes and are dominated by willow and mountain alder (*Alnus incana*). Sedges (*Carex* spp.), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.) are the primary species in palustrine emergent wetlands. The dominant species in aquatic bed wetlands depend on bottom substrate. Aquatic beds along shorelines tend to support watercress. Pondweed is common in streams or ponds with silt bottoms; ballhead waterleaf (*Hydrophyllum capitatum*) occurs in rocky substrates (Corps 1994).

Over 30 rare plant species tracked by the Wyoming Natural Diversity Database (WYNDD) occur in the vicinity of Jackson Hole Levees (table 6-3; Corps 1994). None of these species are Federally listed or proposed as threatened or endangered, but three are protected on U.S. Forest Service (USFS) lands. Those species listed in table 6-3 are considered extremely rare (5 or fewer occurrences) to rare (21 to 100 occurrences) in Wyoming or regionally. It is highly unlikely any of these species occur within the work areas between the levees. The west side of Area 4 and east side of Area 1 would have wetland habitat that includes moist soil plants that may include those listed in table 6-3 (Corps 1994). Work should not take place outside of gravel bars or gravel channels that feed from the main river channel. Work would disturb the cobble soils within the river corridor. Care must be taken to minimize these disturbances. Monitoring for noxious weeds would be needed to ensure they do not spread within areas above the primary flood zone of the river channel.

6.3.2 Wildlife

The Jackson Hole, Wyoming, area is known for its diverse wildlife in the valley and surrounding mountains. The following paragraphs describe the dominant wildlife groups associated with the environmental restoration project areas. The WYNDD has tracked 25 species that occur in the vicinity of Jackson; 22 may use habitats near the environmental restoration project areas (table 6-4, Corps 1994). Five of these species are Federally listed as threatened or endangered and are discussed in paragraph 6.3.2.6. Most of the remainder are considered extremely rare (less than 5 occurrences) to rare (21 to 100 occurrences) in Wyoming and are discussed in the following paragraphs. Construction activity needed to conduct environmental restoration work would involve noise from heavy equipment and human presence. The degree of disturbance from these activities on wildlife would depend on timing and location.

The only habitat losses expected for the environmental restoration project areas would be associated with construction activities and would be short-term. These temporary losses would only affect the few wildlife species that use the relatively disturbed habitats currently associated with the levees and access roads.

Wildlife in the construction area would be disturbed by the environmental restoration work. Wildlife respond to disturbance either by avoidance or habituation. Short-term disturbance (such as that associated with the environmental restoration work) would probably cause temporary avoidance that may disrupt foraging/migration patterns or traditional use for a single season but would have no long-term effects. However, long-term disturbance might cause wildlife to avoid otherwise suitable habitat, effectively resulting in additional habitat loss. Species that cannot avoid disturbance, such as small mammals, may become habituated.

Since construction would occur during the day, mammals that are mobile and diurnal or nocturnal would be relatively unaffected by the associated disturbance. Some species may temporarily relocate bedding areas.

See table 6-5 for the Priority I, II, and III Wyoming Species as of 1997 (Deibert, P. pers. comm.). The lists are prioritized for the species of concern and the habitats that these species use. Habitats include stream class (Class 1 is a blue-ribbon trout stream) and big game critical range/parturition areas.

These species and ranges are valued from irreplaceable to high value within the WGFD. These species are not listed on the Federal list but are mentioned because of their local importance.

Figure 6-2. Summary of PSS Vegetation Projections.

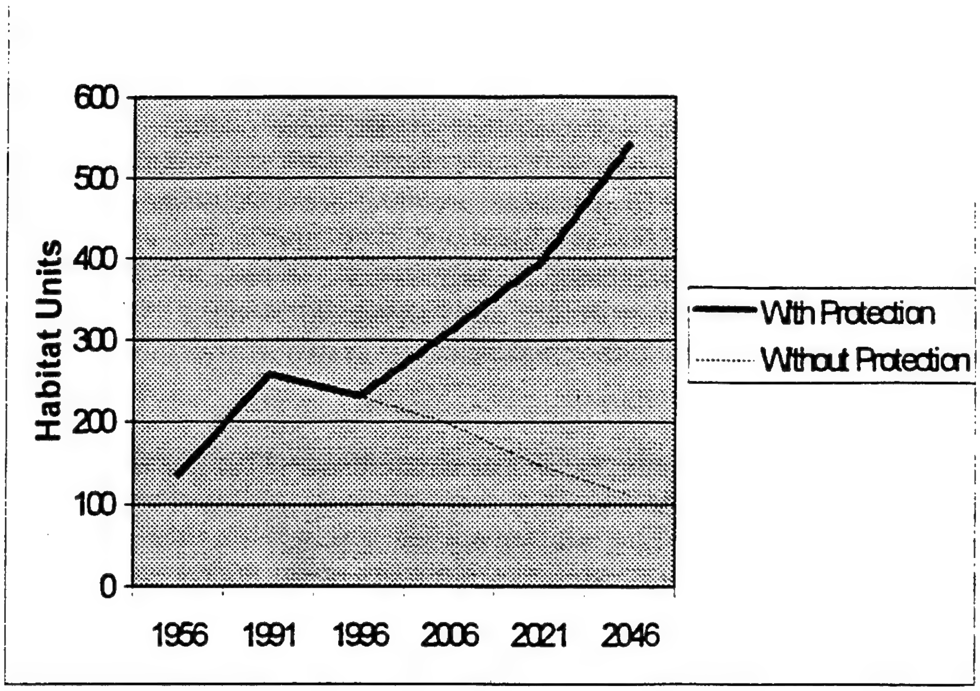

Figure 6-3. Summary of PF Vegetation Projections.

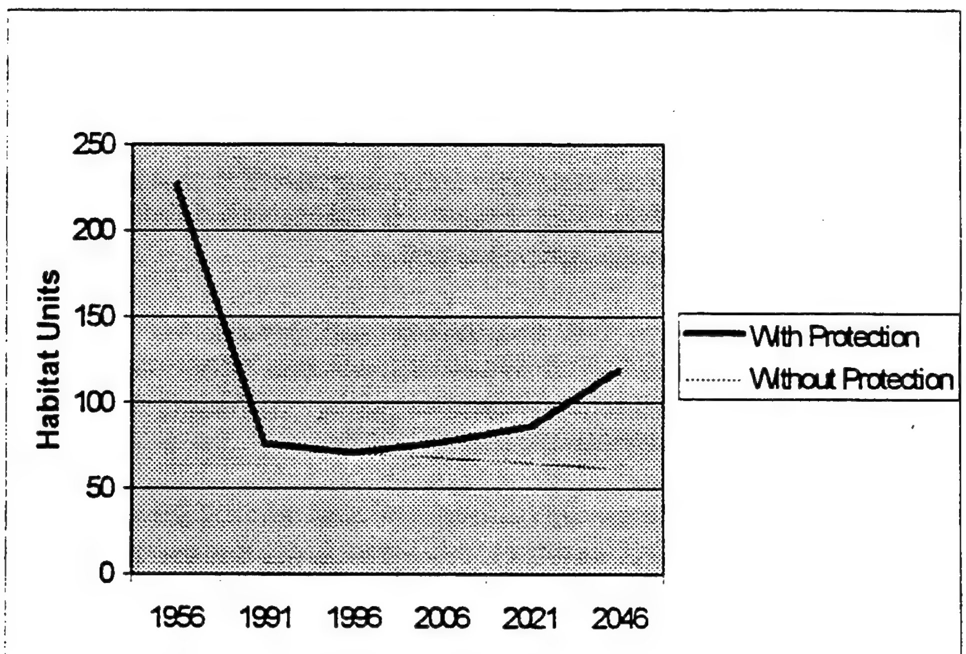

Table 6-3. Partial list of Plant Species Identified by the WYNDD that may Occur Near the Environmental Restoration Project Areas.[1/]

Common Name	Scientific Name	Federal Status[2/]	WY List & Rank[3/]	Habitat[4/]
Oak fern	*Gymnocarpium dryopteris*		2, S1	Moist banks of creeks; moist woods; and wetland/seep areas in spruce/subalpine fir forests on talus.
Steer's head	*Dicentra uniflora*		2, S2	Forest clearings; open slopes with sparse vegetation; rocky soils; sagebrush communities; and disturbed sites.
Boreal draba	*Draba borealis*	USFS	1, S1	Moist soils along streams and on shaded north-facing slopes; calcareous substrate/talus.
Marsh cinquefoil	*Potentilla palustris*		S2	Wetlands; moist places.
Railhead milkvetch	*Astragalus terminalis*		2, S1	Sagebrush grasslands on westerly slopes; river bottoms.
Nuttall townsend-daisy	*Townsendii nutalli*		3, S3	Sandy open areas.
Southern naiad	*Najas guadalupensis*		S1	Warm ponds.
Nodding fescue	*Festuca subulata*		S2	Wet thickets; moist to dry woods; meadows.
Frie's pondweed	*Potamogeton friesii*		S1	Shallow water.
Blunt-leaf pondweed	*Potamogeton obtusifolius*		2, S1	2 to 4 feet of water over soft, mucky bottoms.
Buxbaum's sedge	*Carex buxbaumii*		2, S2	Along shorelines; wet meadows next to lakes.
Fernald alkali grass	*Puccinella fernaldii*		2, S1	Willow thickets, usually in water.
Pale duckweed	*Lemna valdiviana*		2, S1	Warm ponds.
Giant helleborne	*Epipactis gigantea*	USFS	1, S1	Moist meadows in vicinity of calcareous ponds; streambanks; lake margins; and near springs.
Broad-leaved twayblade	*Listera convallariodes*	USFS	2, S1	Grassy areas under aspen-alder.

[1/] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.*, alpine talus and wet limestone cliffs) that do not occur near work areas.

[2/] Federal Status: C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data insufficient to support listing. USFS - Species is considered sensitive by the USFS.

[3/] State List: List 1 (Highest Priority) - Includes the following: (1) Federally listed and proposed threatened and endangered species and category 1 and 2 candidates for listing (except where current data indicate such status is inappropriate); (2) species designated sensitive on Federal lands or that are being recommended for sensitive designation by the WYNDD; and (3) other species that are quite rare and/or threatened globally or regionally but that have no formal protection status. List 2 (Medium Priority) - Includes the following: (1) species on designated Watch Lists for Federal lands or that are being recommended for Watch Lists by WYNDD, and (2) other species that are moderately rare and/or somewhat threatened globally or regionally. List 3 (Lowest Priority) - Includes the following: (1) species previously considered high or medium priority, but downranked as new information became available, or (2) species that are rare in Wyoming, but common and secure in adjacent areas.

State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences).

[4/] Habitat: As described in the WYNDD and Hitchcock and Cronquist 1981.

Table 6-4. Partial List of Wildlife Species Identified by the WYNDD that may Occur Near Environmental Restoration Project Areas.[1]

Common Name	Scientific Name	Federal Status[2]	WY List & Rank[3]	Mgmt. Status[4]	Habitat[5]
Boreal western toad	*Bufo boreas boreas*	C2	S2		Wide variety of habitats-streams, woodlands, meadows.
Spotted frog	*Rana pretiosa*	C2	S3	S-USFS	Near permanent water.
Northern leopard frog	*Rana popiens*		S3S4		Wide variety of habitats.
Common loon	*Gavia immer*		S2BS4N	I-WGFD S-USFS	Lakes.
Trumpeter swan	*Cygnus buccinator*	C2	S1S2BS2N	I-WGFD S-USFS	Lakes, rivers.
Harlequin duck	*Histrionicus histrionicus*	C2	S2BS2N	S-USFS	Swift streams.
Osprey	*Pandion haliaetus*		S3S4BS4N		Along rivers/streams/lakes.
Bald eagle	*Haliaeetus leucocephalus*	LE	S1BS2N		Primarily along rivers and other waterbodies.
Northern goshawk	*Accipiter gentilis*	C2	S4BSZN		Conifer forests; hunts in open areas.
Merlin	*Falco columbarius*		S2S3BSZN	II-WGFD	Open forests and a variety of habitats.
Peregrine falcon	*Falco peregrinus anatum*	LE	S1BS1N		Open wetlands near cliffs.
Whooping crane	*Grus americana*	LE	SHBS1N		Freshwater marshes.
Long-billed curlew	*Numenius americanus*	3C	S3BS4N	III-WGFD	Wet and dry grasslands.
Flammulated owl	*Otis flammeolus*		S1BSZN	S-USFS	Woodlands.
Great gray owl	*Strix nebulosa*		S2B2N	S-USFS	Dense conifer forest; hunts in open wet areas.
Silver-haired bat	*Lasionysteris noctivagans*		S3		Dense conifer forest; hunts in open areas.
Hoary bat	*Lasiurus cinerus*		S3	III-WGFD	Dense conifer forest; hunts in wet open areas.
Long-eared myotis	*Myotis evotis*		S5		Dense conifer/mixed forests; hunts in forests and near water, wetlands.
Gray wolf	*Canis lupus*	LE	SH		Wide variety of habitats.
Grizzly bear	*Ursus arctos*	LT	S1S2		Wide ranging-almost all habitat types.
River otter	*Lutra canadensis*		S3	III-WGFD	Rivers and streams.
American bison	*Bison bison*		S4		Grasslands, open areas.

[1] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.*, alpine talus and wet limestone cliffs) that do not occur in the vicinity of a potential quarry or access/crossing sites.
[2] Federal Status: LE - listed endangered; LT - listed threatened; C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data insufficient to support listing; and 3C - once considered for listing as endangered or threatened but no longer receive such consideration.
[3] State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences); S4 - apparently secure in the state (many occurrences); S5 - demonstrably secure in the state. For migratory birds, each of these categories is assigned to breeding status (B) and migratory status (N); SZN - species are not of significant concern when migrating through Wyoming; and SHB - historical breeder. State ranks may fall between 2 categories (*i.e.*, S1S2B).
[4] Management Status: I-WGFD (Priority I) - includes federally listed endangered and threatened wildlife as well as species in need of immediate attention and active management to ensure that extirpation or a significant decline in population does not occur; II WGFD (Priority II) - species that are in need of additional study to determine whether intensive management is warranted; III WGFD (Priority III) - species whose needs should be accommodated in resource management planning but do not need intensive management; S-USFS - species is listed as sensitive by the USFS in Region 4 (includes the Bridger-Teton National Forest).
[5] Habitat: As described in the WYNDD; Stebbins 1985; National Geographic Society 1987; Brown 1985.

Table 6-5. Priority I, II, and III Wyoming Species as of 1997.

Priority I Species Wyoming (which could occur in study area):

American white pelican (*Pelicanus erythrorhynchos*)
Trumpeter swan (*Cygnus buccinator)*
Black crowned night heron (*Nycticorax nycticorax*)
Common loon (*Gavia immer)*
White-faced ibis (*Plegadis chihi*)
Snowy egret (*Egretta thula*)
Caspian tern (*Sterna caspia*)
Forster's tern (*Sterna forsteri*)

Priority II Species Wyoming (which could occur in study area):

Clark's grebe (*Aechmophorus clarkii*)
Western grebe (*Aechmophorus occidentalis*)
American bittern (*Botaurus lentiginosus*)
Merlin (*Falco columbarius)*
Upland sandpiper (*Bartramia longicauda*)
Black tern (*Chidonias niger*)
Burrowing owl (*Athene cunicularia*)

Priority III Species Wyoming (which could occur in study area):

Long-billed curlew (*Numenius americanus)*
Great blue heron (*Ardea herodias*)
Ferruginous hawk (*Buteo regalis*)
Black-backed woodpecker (*Picoides arctus*)
Masked (Preble's) shrew (*Sorex cinereus*)
Merriam's shrew (*Sorex merriami*)
Hoary bat (*Lasiurus cinerus)*
Wolverine (*Gulo gulo*)
River otter (*Lutra canadensis)*
Lynx (*Felis lynx*)

Other species not listed above:

Loggerhead shrike (*Lanius ludovicianus*)
Goshawk (*Accipiter gentilis)*
Spotted frog *(Rana pretiosa)*
Harlequin duck (*Histrionicus histrionicus)*
Elk (*Cervus elaphus nelson*)
Moose (*Alces alces shirasi*)
Mule deer (*Odocoileus hemionus hemionus*)
Bighorn sheep (*Ovis canadensis canadensis*)

6.3.2.1 Mammals

Elk (*Cervus elaphus nelson*), mule deer (*Odocoileus hemionus hemionus*), Shiras moose (*Alces alces shirasi*), bighorn sheep (*Ovis canadensis canadensis*), and American bison (*Bison bison*) are the most prominent wildlife in the Jackson Hole, Wyoming, area. Aquatic furbearers, black bear (*Ursus americanus cinnamomum*), coyote (*Canis latrans*), and a variety of small and medium-sized mammals also occur.

6.3.2.2 Big Game

Big game concerns focus on usage patterns within the region of Jackson Hole, Wyoming. Important winter feeding areas are located near the work area and migration patterns to and from these feeding areas go through the Snake River drainage. The usage patterns include spring-summer-fall range, winter range, winter/year-long range, critical winter range, and critical winter/year-long range (Corps 1990). The local mule deer, elk, moose, and bighorn sheep herds represent these types of usage. The critical range areas are the areas of greatest concern. Most conflicts would be avoided with the time restrictions imposed by river flows. If heavy excavations (gravel removal and sorting) are performed early in the work window and work takes place during daylight hours, conflicts would be minimized even further. It is recommended by the WGFD to cease work by November 15. Depending on the year, there may be opportunities to extend the work window into December or beyond if WGFD biologists are consulted and conditions warrant an extension.

The Jackson Hole, Wyoming, area has one of the largest populations of elk in North America. Jackson Hole and the surrounding mountains provide about 1,000 square miles of summer range for approximately 15,000 elk. During the winter, the populations concentrate in much smaller areas. The National Elk Refuge just northeast of Jackson, Wyoming, provides about 24,000 acres of winter habitat for 10,000 elk. The refuge includes winter range and a supplemental feeding area for elk (Corps 1994). The WGFD classifies this refuge as a crucial winter range, which is defined as one that determines whether the elk population in the area reproduces and maintains itself at or above WGFD target levels. In addition to the refuge, there are several other smaller wintering areas used by elk in the upper Snake River drainage (Corps 1994).

The Jackson Hole, Wyoming, area provides habitat for mule deer throughout the year. Mule deer use the area primarily for migration. The Sublette herd winters in the Green River Basin to the east. A small herd of mule deer winter in the South Park Elk Feed Grounds area (Corps 1990).

The upper Snake River drainage provides year-round habitat for about 200 to 300 moose. During the winter, an additional 400 to 500 moose from the surrounding uplands migrate into the river bottom area (Corps 1994). Winter densities range

from 4.3 moose per mile between the South Park and Wilson Bridges to 6 moose per mile between Wilson Bridge and the confluence of the Gros Ventre River (Corps 1994).

Bighorn sheep are present seasonally in all major drainages within the Snake River and Gros Ventre River Basins (Corps 1994). The Gros Ventre drainage contains the primary wintering area for bighorn sheep that summer in the Gros Ventre Wilderness. In addition, a major wintering area occurs at Camp Davis. approximately 4 miles southeast of the confluence of the Hoback River. Sheep use steep slopes and breaks along the Snake and Hoback Rivers year-round. Brush and grassland areas at high elevations, within these drainages, are the primary feeding areas for bighorn sheep (Corps 1994). The following are big game usage for the specific environmental restoration project areas:

Area 1

This area has been designated as a critical moose (Sublette unit) wintering/year-long area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk from the Fall Creek unit migrate to reach the state feeding grounds located downstream of this site. Elk use the area primarily for winter range. Bighorn sheep of both the Targhee and Jackson units and mule deer of the Sublette unit use the area primarily as spring, summer, and fall range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) would be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 4

This area is critical moose (Sublette unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk from the Fall Creek unit migrate to reach the state feeding grounds located downstream of this site. Elk use the area primarily as winter range. Bighorn sheep of the Targhee unit and mule deer from the Sublette unit use the area for spring, summer, and fall range. Since most work will be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 9

This area is critical moose (Jackson unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk of the

Jackson unit use the area primarily for migration. Bighorn sheep of the Targhee unit and mule deer from the Jackson unit use the area for spring, summer, and fall range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 10

This area is critical moose (Jackson unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk of the Jackson unit use the area primarily for migration. Bighorn sheep of the Targhee unit and mule deer from the Jackson unit use the area for spring, summer, and fall range. Mule deer from the Jackson Hole unit also use the area as critical winter range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

6.3.2.3 Other Mammals

Shrews (*Sorex* spp.) and voles (*Microtus* spp.) are common in riparian areas along the Snake River and its tributaries and would be expected to inhabit the environmental restoration project areas. Aquatic furbearers such as beaver (*Castor canadensis*), mink (*Mustella frenata*), and muskrat (*Ondatra zibethicus*) are commonly seen in streams, ponds, and backwater areas along the Snake River near Jackson, Wyoming. The levees are generally too rocky or exposed to provide habitat for either the beaver or muskrat. Beaver frequently construct dams in the Jackson Hole area (Corps 1994).

There are four mammal species (excluding Federally listed or candidate species) occurring in the Jackson Hole area that are tracked by the WYNDD table 6-4. The river otter (*Lutra canadensis*), a species considered rare in Wyoming, has been documented by the WYNDD. This species has been observed along the Snake River near logjams, pools, and oxbows that concentrate fish (Corps 1994). The hoary bat (*Lacers cinerus*), also considered rare in Wyoming, has been reported in the Jackson Hole area. Two other rare species, including the silver-haired bat (*Lasionycteris noctivagans*) and long-eared myotis (*Myotis evotis*), have been documented by the WYNDD in the Jackson Hole area. Wolverine (*Gulo gulo*) and lynx (*Felis lynx*) are also rare and occur in the region.

Small- and medium-sized mammals would be affected by disturbances associated with construction at environmental restoration project areas. Many of these species

would avoid areas subject to disturbance; others would habituate. The river otter would likely temporarily avoid the environmental restoration project areas during construction but would not experience any long-term effects from disturbance.

6.3.2.4 Birds

The upper Snake River drainage provides habitat for a wide variety of resident and migratory birds, including waterfowl, raptors, and passerines. Approximately 150 different species have been observed, and 119 are documented or expected to breed in the area (Corps 1994).

The Corps would schedule construction activities at the environmental restoration project areas, which have critical waterfowl brood-rearing habitat, after nesting season to avoid impacts to nesting waterfowl and other birds. Construction at these sites would be scheduled after August 1 or 15 if bald eagle constraints apply (see paragraph 6.3.2.6.1). Resident birds and migrants (including several species considered rare in Wyoming) would be expected to temporarily avoid foraging or staging in areas subject to disturbance. No impacts to wintering birds, including the trumpeter swan, would be expected because construction activities for restoration would not occur at this time.

6.3.2.4.1 Waterfowl and Water Birds

The wetlands, ponds, backwater, and tributary creeks in the Snake River floodplain provide habitat for waterfowl and waterbird spring/fall staging, breeding, nesting, brood rearing, and wintering. The most prominent include Canada geese (*Branta canadensis*), trumpeter swans (*Cygnus buccinator*), and sandhill cranes (*Grus canadensis*); but common mergansers (*Mergus merganser*), mallards (*Anas platyrhynchos*), buffleheads (*Bucephala albeola*), and Barrow's goldeneyes (*B. islandica*) are also common seasonally. Frequently observed waterbirds include the American white pelican (*Pelecanus erythrorhynchos*), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), western grebe (*Aechmophorus occidentalis*), and cormorant (*Phalacrocorax auritus*). Rarer migrants would include American bittern (*Botaurus lentiginosus*), black tern (*Chidonias niger*), Caspian tern (*Sterna caspia*) and Forster's tern (*Sterna forsteri*), white-faced ibis (*Plegadis chihi*), Clark's grebe (*Aechmophorus clarkii*), and snowy egret (*Egretta thula*). Long-billed curlew (*Numenius americanus*) and upland sandpiper (*Bartramia longicauda*) would be associated with the upland shrub-steppe habitat. They may be found along the river corridor foraging during migration.

Of the species listed above, only two would have a high potential for nesting/living in the work area: the black-crowned night heron and great blue heron. The ibis and snowy egret may be seen in wetland areas outside of the levee system during migration. Western and Clark's grebes would be associated with the lakes and ponds in the region. The other species listed could live in the forest/woodlands adjacent to the river or migrate through the riverine system. Because work would be

restricted to outside of the nesting season and removal of existing trees and shrubs would be avoided wherever possible, impacts to these species should be minimal or nonexistent.

On average (1982 through 1987), approximately 1,320 dabbling and 666 diving ducks winter on the river between Moose Junction and South Park (Corps 1994). Between Wilson and South Park Bridges, winter duck densities frequently average 139 per mile of river and tributary. This area is considered crucial winter waterfowl habitat (Corps 1994). Much of this same area is also considered crucial brood-rearing habitat (Corps 1994).

The harlequin duck (*Histrionicus histrionicus*), a candidate for Federal listing as threatened or endangered, is a species considered very rare in Wyoming and has been documented by the WYNDD in the Jackson Hole area (table 6-4). The common loon (*Gavin immer*), also rare in Wyoming and intensively managed, has been reported in the Jackson Hole area.

About 42 breeding pairs of Canada geese use the Snake River between the confluence of the Gros Ventre River and South Park Bridge. These consist of 22 pairs north of the Wilson Bridge and 20 pairs to the south (Corps 1994). The most important goose nesting areas include the confluence of the Gros Ventre River, the confluence of Blue Crane Creek, and between the confluence of the Spring Fork of Fish Creek and the confluence of Spring Fork of Spring Creek (Corps 1994). Stable islands with trees and logs that provide the cover necessary to reduce nesting losses from avian predation characterize these areas (Corps 1994). Areas 1, 4, and 10 are located near these nesting sites.

Brood-rearing habitat for Canada geese along the Snake River includes grazed meadows, ponds, gravel pits, and islands. The most important brood-rearing habitat is found in the following locations: (1) in wet meadows on the National Elk Refuge; (2) along the east side of the Snake River from the confluence of the Gros Ventre River to the Wilson Bridge; (3) the Snake River between Wilson and South Park Bridges; (4) the area between Fish Creek and the Snake River south of the landing strip; (5) South Park; and (6) about 2 miles of Flat Creek upstream from its confluence (Corps 1994). All environmental restoration project areas are within Canada goose brood-rearing habitat.

Between 1982 and 1988, the upper Snake River supported an average of 390 wintering Canada geese (Corps 1994). Wintering habitat is often limited by the lack of ice-free water. Crucial winter habitat includes: (1) nearly all of the river between the Wilson and South Park Bridges; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 2 miles of Flat Creek upstream from its confluence (Corps 1994). Other wintering areas include the river upstream of Wilson Bridge and two small off-river areas north of the bridge (Corps 1994). All of the environmental restoration project sites are within crucial Canada goose winter habitat.

The trumpeter swan is a candidate for Federal listing as threatened or endangered and is considered extremely rare in Wyoming. This species is intensively managed by the WGFD and is designated as sensitive by the USFS in the Jackson Hole area (table 6-4). In 1988, a total of 98 trumpeter swans wintered in the Jackson Valley, Grand Teton National Park, and the National Elk Refuge (Corps 1994). Trumpeter swan winter habitat in Wyoming, Idaho, and Montana appears to have the following characteristics (Corps 1994):

- soft substrate less than 2 inches deep;
- water less than 4 feet deep;
- channel greater than 50 feet wide;
- banks with no trees or shrubs;
- loafing sites with water less than 4 inches deep or sand/gravel bars in or near feeding areas;
- no physical barriers that bisect feeding or loafing areas or travel corridors;
- shallow water containing beds of diverse aquatic macrophytes that are available for at least 75 percent of the winter and not iced over for more than 2 or 3 days at a time; and
- water velocity in feeding areas that does not exceed 1 1/2 feet per second.

The Snake River, from the start of the Right Bank Federal Levee to just south of the Wilson Bridge, is considered potential wintering habitat for the trumpeter swan (Corps 1994). The river in this area is less than optimal for wintering swans because of the lack of calm water and absence of aquatic vegetation. Crucial winter habitat for trumpeter swans is provided by the following areas: (1) the Snake River downstream of the Wilson Bridge; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 1 mile of Flat Creek upstream from its confluence (Corps 1994). The Fish Creek, South Park area, and lower Flat Creek wintering areas received about 5,951 swan use days per year between 1982 and 1986 and 7 to 14 breeding pairs rely on these areas annually (Corps 1994). Fish Creek is the most heavily used of these areas and Flat Creek the least. Environmental restoration project Areas 1 and 4 south of Wilson Bridge are within crucial winter habitat for the trumpeter swan (Corps 1994).

There are several nesting pairs of trumpeter swans in the Jackson Hole area and there are at least three specific areas that are important for brood rearing (Corps 1994). None of the environmental restoration project areas are near trumpeter swan nests or brood-rearing locations.

Sandhill cranes nest in the upper Snake River drainage, primarily in beaver ponds and seasonally flooded emergent wetlands. This area supports between four and eight pairs of nesting cranes annually, but none are near the environmental restoration project areas (Corps 1994).

During spring migration, about 30- to 100-sandhill cranes use the meadows between South Park area and Spring Creek (Corps 1994). Area 1 is the only work site near this staging area.

The proposed work has the potential to impact some of these species. The timing of the work would minimize these impacts since breeding season will be coming to an end. Care will be needed to avoid impacting water birds, especially at Areas 1 and 4. Most of the birds would avoid the construction zones. Workers should take care not to injure or unduly harass water birds that may be found during construction activities.

6.3.2.4.2 Raptors

The upper Snake River and associated habitats support high numbers of fish and small mammals that provide prey for a variety of raptors. The most commonly observed raptors are the osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (B. *swainsonii*), and American kestrel (*Falco sparverius*). Other raptors known to occur in this area include ferruginous hawks (*Buteo regalis*), golden eagles (*Aquila chrysaetos*), western screech owls (*Otis kennicotii*), great horned owls (*Bubo virginianus*), and short-eared owls (*Asio flammeus*) (Corps 1994). Rarer hawks include the goshawk (*Accipiter gentilis*) and merlin (*Falco columbarius*). Most of these raptors nest in trees behind the levees.

Annually, three to four pairs of osprey nest along the Snake River in the Jackson Hole area, usually in partially or completely dead standing trees or artificial structures (Corps 1994). Approximately seven osprey nest sites have been documented along the Snake River between the beginning of the Left Bank Federal Levee and South Park Bridge (Corps 1994). All of the environmental restoration project areas are in the vicinity of these osprey nest sites. The osprey is considered rare or uncommon in Wyoming (table 6-4).

Two owl species tracked by the WYNDD (excluding Federally listed or candidate species) occur in the Jackson Hole area (table 6-4; Corps 1994). The flammulated owl (*Otis fammeolus*), considered extremely rare, and great gray owl (*Strix nebulosa*), considered very rare in Wyoming, have been seen in the vicinity of the Snake River downstream of the environmental restoration project areas.

Burrowing owls (*Athene cunicularia*) are found in the Wyoming. They migrate to the state primarily for breeding. They are associated primarily with prairie dog towns but will nest in the burrows of other mammals. It is highly unlikely that burrowing owls use the Jackson Hole area because of the lack of prairie dog towns and the short warm season. This type of habitat would not be found in the Snake River corridor so the environmental restoration work would not affect this species.

Raptors would avoid construction activities until they habituate to it. Workers should take care not to unduly harass raptors that might be found during work activities.

Removal of existing vegetation should be avoided wherever possible. Bald eagles are discussed in paragraph 6.3.2.6.

6.3.2.4.3 Other Birds

Other birds known to commonly occur in the Snake River floodplain near the Jackson Hole area include the loggerhead shrike (*Lanius ludovicianus*), black-backed woodpecker (*Picoides arctus*), killdeer (*Charadrius vociferus*), tree swallow (*Tachycineta bicolor*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), common nighthawk (*Chordeiles minor*), belted kingfisher (*Ceryle alcyon*), and Wilson's warbler (*Wilsonia pusilla*) (Corps 1994). These species and others would be expected to occur in the vicinity of the environmental restoration project areas. These species would face the same impacts as water birds and raptors.

6.3.2.5 Reptiles and Amphibians

Relatively little is known about amphibians and reptiles in the Jackson Hole area. Two frog species, the spotted frog (*Ranu pretiosa*), and northern leopard frog (*Ranu pipiens*); and one toad species, the boreal western toad (*Bufo bufo boreas*), considered very rare or rare in Wyoming, have been documented in the vicinity of the environmental restoration project areas (table 6-4). The sagebrush lizard (*Sceloporus graciosus*) and western terrestrial garter snake (*Thamnophis elegans*) are probably two of the most common reptiles in the area. The existing riparian vegetation within or near the environmental restoration work could have these species present. These species would be impacted if present within the side channels when construction activities are taking place. Most reptiles and amphibians would move from the area, but a few individuals may be injured or killed inadvertently. The timing of the work in late summer and fall would reduce these impacts.

6.3.2.6 Threatened and Endangered Species

The USFWS has documented five species in the Jackson Hole area that are classified as threatened or endangered. Endangered species observed in this area include the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), and peregrine falcon (*Falco peregrinus*). The Jackson Hole area is also within historical range for the grizzly bear (*Ursus arctos horribilis*), a threatened species, and gray wolf (*Canis lupus*), an endangered species (Corps 1994).

6.3.2.6.1 Bald Eagle

The upper Snake River drainage provides year-round habitat for bald eagles. Nesting usually occurs between February 1 and August 15. The Snake River population unit, which includes the Snake River in Wyoming, its tributaries, and Jackson Lake, consisted of 24 known breeding pairs in 1982 (Corps 1994). In 1992, seven active bald eagle nest sites existed between Moose and South Park Bridge,

including one just downstream of Moose, one near the confluence of the Gros Ventre River, and five between the Wilson and South Park Bridges (Corps 1994). Between 1982 and 1989, the productivity of bald eagles nesting between Moose and the South Park Bridge averaged 1.47 young per nesting attempt, a number considered excellent (Corps 1994).

Bald eagles in the Jackson Hole area feed primarily on fish in the summer and waterfowl and carrion in the winter. Between 5 and 15 bald eagles have been observed during the winter along the Snake River between Moose and the South Park Bridge prior to 1994 (Corps 1994). This entire reach has been designated by WGFD as crucial wintering and nesting habitat (Corps 1994). All of the environmental restoration project areas are contained within this habitat.

In the past in Area 1, a bald eagle nest has been mapped toward the north end of the trees on the east side of the channel. No active nests were located in this area during 1998.

Bald eagles nested near Area 4 in 1998. Two active nests were located on the east side of the river. One nest was located about 2 1/2 to 3 miles south of the Wilson Bridge, 50 yards outside the levee. The second nest was about 1 1/2 miles south of the first nest, 3 to 4 hundred yards outside of the levee. Both nests were on private property.

Bald eagles nested near Area 9 in 1998. The nest was located on the west side of the river, outside of the levee, near human habitation.

Bald eagles nested near Area 10 in 1998. The nest was located in a grove of trees on the north side of the Gros Ventre River near the mouth. Both eagles were spotted during a tour of the area in 1998.

The CAR received from the USFWS (appendix B) stated, "No work activity within 1 mile of any active nests would occur between February 1 and August 15." For this reason, work would only be allowed within 1 mile of active nests (current year) between August 16 and January 31. Changes to this work window must have prior approval from the USFWS. No other constraints have been applied to nesting bald eagles. Since it is still unknown when work will actually commence, the environmental restoration project area would have to be surveyed for bald eagle nest each spring of the year when work is to be performed.

Because of the equipment access restrictions due to river flows, construction and excavation activities should not conflict with nesting. All standing mature trees in the work area would be avoided if at all possible. Trees that are leaning or already on the ground may be moved aside to facilitate excavation and construction. All of the known eagle nesting trees are currently located outside of the levee system. The biologist on site would work with the construction crew to avoid areas where equipment could damage mature trees.

Bald eagles would also be wintering in the area. The biologist on site would monitor for the presence of eagles and provide guidance to the work crews to avoid activities that might disturb the eagles. It is not anticipated that the work activity would cause additional disturbance to the eagles using the area beyond the human disturbance already occurring through normal recreational use.

Bald eagles are likely to be found in or near the work area most of the year. The chances of the environmental restoration project having any impact on the bald eagle are minimal due to the timing of the active work. There would likely be no direct impacts (mortality, loss of nest, *etc.*) or long-term population impacts (reduced reproduction, *etc.*). There may be some minor displacement of foraging or roosting eagles.

6.3.2.6.2 Peregrine Falcon

Until recently, the peregrine falcon was considered extirpated from Wyoming (Corps 1994). A recovery program was begun in 1980. Between 1980 and 1987, 153 peregrine falcons were released to hack sites (the term used for reintroduction sites) in Wyoming, primarily in Yellowstone National Park and in or near the National Elk Refuge. In 1986 and 1987, each year 25 peregrine falcons were released to 5 hack sites in Wyoming. One of these hack sites is located northwest of Wilson and another is on the National Elk Refuge. Approximately 80 to 83 percent of the released birds reached independence (Corps 1994).

The wetlands and streams along the Snake River south of Wilson Bridge support a variety of birds that are prey for peregrine falcons. This area is considered forage habitat for peregrine falcons and three to four adults and sub-adults have been observed in this region between 1982 and 1988 (Corps 1994).

In 1988, 6 nesting pairs of peregrine falcons in Wyoming produced 10 young (Corps 1994). In 1998, two eyries (nest sites) were located in the vicinity of the Grand Teton Mountains. Currently, one peregrine falcon forages in the South Park area near Fish Creek. This area is near the West side of Area 4.

Peregrine falcons are expected to leave the area soon after nesting is complete. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August. The biologist on site would monitor for the presence of peregrine falcons and provide guidance to the contractor to avoid activities that might disturb the peregrine falcons. Since the bulk of the environmental restoration work would occur after nesting season, the chance of the environmental restoration project impacting the foraging of peregrine falcons would be minimal.

6.3.2.6.3 Whooping Crane

The whooping crane is one of the rarest birds in North America. Reintroduction efforts at Gray's Lake National Wildlife Refuge in Idaho have resulted in whooping cranes occupying habitat in western Wyoming since 1977. In 1985, about 26 to 31 whooping cranes in the Gray's Lake population spent the summer in Wyoming. In 1988, only 16 of the Gray's Lake flock were still alive. Whooping cranes are occasionally sighted in the Jackson Hole area, primarily along the Gros Ventre River (Corps 1994).

Whooping cranes do migrate through the area of Jackson Lake during early spring. There is a chance a whooping crane may stop along the river in the Jackson Hole area, especially if sandhill cranes are using the area. The chances of a whooping crane stopping in the work area would be extremely rare. The whooping cranes would be attracted to wetland pastures and not the riverine corridor between the levees. The confluences of Blue Crane and Fish Creeks are the only two areas that might attract cranes. Areas 1 and 4 are within this region of the river. Most of the work would be taking place between August 15 and November 15. For these reasons, the environmental restoration project would have little or no impacts on the whooping crane population.

If a whooping crane is seen during work activities, work would cease. The WGFD and USFWS personnel would be contacted. Work would resume only after USFWS personnel have been consulted on how to proceed.

6.3.2.6.4 Grizzly Bear

The historical range of the grizzly bear once included most of Western North America. Currently, only six areas in the United States, including Yellowstone and Grand Teton National Parks, support self-sustaining grizzly bear populations (Corps 1994).

The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area. Current management in Wyoming by WGFD is to discourage grizzly bears from living in areas of human habitation. The last sighting of grizzly bears in the Jackson Hole area was in 1994. An adult female with three cubs was captured near Area 4 and relocated to an area north of Jackson Hole. The female was attracted to the area because 15 cows, which were killed by lightning, were buried near the site. The biggest concern with this species is attracting them to the Jackson Hole area.

The chances a bear will be seen on site would be very rare, but precautions are needed since late summer/fall is the time of highest bear activity as they search for food in preparation for hibernation. Workers would be directed not to leave food and other garbage on site that may attract bears to the area. Some of these stipulations could include keeping the work site free of food and garbage and storing trash and food in approved containers. If a grizzly bear is seen during work activities, WGFD

and USFWS personnel would be contacted. Since there is only a slight chance of encounters between grizzly bears and humans, the proposed work is unlikely to have an impact on the grizzly bear population.

6.3.2.6.5 Gray Wolf

The gray wolf historically inhabited all habitats in the Northern Hemisphere except tropical rain forests and deserts (Corps 1994). Currently, the largest populations of wolves in the lower 48 states occur in northern Minnesota. Remnant populations are believed to exist in Wyoming, Washington, Idaho, Montana, Michigan, and Wisconsin (Corps 1994). In the summer of 1992, a wolf was sighted in Yellowstone National Park, the first documented observation in over 20 years. Wolves have been sighted this year following the elk herds into the Jackson Hole area (WGFD 1998, USFWS 1998). Up until this year, there had been no sightings of wolves near Jackson, Wyoming. The wolves following the elk are unlikely to go near the town of Jackson. They would likely stay in the hills surrounding the elk refuge. The wolves avoid human activities including the construction work associated with this environmental restoration project. Like the grizzly, an effort should be made to avoid attracting wolves to human habitation. The same guidelines associated with grizzly bear management should be applied to gray wolves. This includes keeping the site clean of food debris and other garbage. If dead animals are found on or near the work site, they should be removed and disposed of properly. If a gray wolf is seen during work activities, WGFD and USFWS personnel would be contacted.

6.4 AIR QUALITY

Air quality in the Jackson Hole area is generally very good due to low population density, distance from major cities, and lack of large industrial sources of air pollution. The most significant sources of atmospheric emissions in the area are prescribed burns and wildfires. The Bridger-Teton National Forest includes areas in which fires are used to enhance wildlife habitat and to dispose of logging residues (personal communication, F. Kingwell, Forest Service, Bridger-Teton National Forest, Jackson, Wyoming, March 10, 1989/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994, Corps). There are no major point sources of air pollution in the area. Consequently, the most significant emission sources are forest fires, automobiles, and residential wood-burning stoves (personal communication, B. Daily, Wyoming Department of Environmental Quality (DEQ), Cheyenne, Wyoming, April 7, 1993/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). Based on current information, ambient air quality standards in Jackson are not being exceeded (personal communication, L. Gribovicz, Wyoming DEQ, Lander, Wyoming, September 16, 1998).

The operation of trucks and other equipment that generate emissions would only occur during the brief fall work window. Construction would occur at only one of the environmental restoration project areas per work season; therefore, emissions would

not be generated at all four areas simultaneously. Increases in emissions from equipment operation at any one of the environmental restoration project areas are expected to be minimal, of short duration, and are not expected to result in a detectable level beyond those currently generated in the Jackson Hole area. Based on this, air quality impacts from emissions are expected to be short-term and negligible. Emissions would not result in any long-term, permanent impacts upon air quality.

Trucks traveling on unpaved roadways may generate dust while transporting supplies and materials. Dust may also become airborne from equipment operation on the gravel bars and levees. Virtually all of the unpaved roads are remotely located; therefore, impacts from fugitive dust along the roadways are expected to be minimal. Negligible amounts of dust are expected to be generated from operation of equipment on gravel deposits between the levees. To minimize the potential for fugitive dust, speed limits for operation of equipment on the gravel bars and upon the levees may be necessary. Because the levees are constructed primarily of rock, only minor concentrations of fugitive dust are expected to be generated by the operation of trucks on the levees. Based on the imposition of speed limits for equipment and minimal potential for generation of dust on the levees, impacts from the generation of dust by equipment operation on gravel bars, roads, and levees are expected to be minimal. No long-term, permanent impacts would occur from fugitive dust.

The generation of dust by cobble screening activities is also expected to be negligible or nonexistent due to the moisture content of the material being screened. Recreational users may experience dust when passing through the immediate vicinity of the screening operation; however, the impact would be of short duration. Overall, any air quality impacts that might occur as a result of cobble screening are expected to be negligible and of short duration.

6.5 LAND USE

Land use in Teton County is heavily influenced by landownership patterns. Federal land in the county is used primarily for recreation, wilderness, wildlife management, and forestry. Private land is primarily classified as agricultural, although the use of land for agricultural purposes has diminished over the years (U.S. Bureau of the Census 1989 and Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). Over the past few decades, land previously classified as agricultural has been converted to residential and other nonagricultural uses.

The Federal government is the largest landowner (97 percent) in the 4,000 square miles of Teton County. The USFS administers most of the Federal lands in three national forests within the county, which together comprise approximately 77 percent of the land in the county. Of the three national forests, the Bridger-Teton National Forest has approximately 1,096,000 acres, the most in the county. Other Federal

agencies that manage land within Teton County include the National Park Service. which administers Grand Teton National Park (310,000 acres); the USFWS, which manages the National Elk Refuge (approximately 24,000 acres); the Bureau of Reclamation, which manages Jackson Lake Dam; and the Bureau of Land Management (BLM), which manages approximately 9,000 acres, primarily near the Snake River (Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994).

Lands within the three national forests in the county are managed for timber production, recreation, wildlife habitat, and wilderness. At Grand Teton National Park, land use is conservation and recreation oriented. National Elk Refuge land is maintained as wildlife habitat. The BLM leases land for grazing and manages some land within Teton County for recreation (primarily near the Snake River).

The State of Wyoming owns approximately 10,000 acres in the county as either school trust lands or resource lands. The WGFD manages 2,000 acres of State-owned land primarily as wildlife habitat but allows some camping. State trust lands comprise approximately 8,000 acres in Teton County of which approximately 1,900 acres are leased to the WGFD; 5,000 acres are leased to grazing and agricultural uses; and the remaining acres are not leased (personal communication, D. Force, Wyoming State Land Farm Loan Office, Cheyenne, Wyoming, August 31, 1992, and Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994).

Private property accounts for approximately 3 percent (75,000 acres) of Teton County. Of the privately owned land, approximately 1,160 acres are contained within the town of Jackson corporate limits. The size of privately-owned parcels varies from small in-city lots to farms and ranches over 2,000 acres.

Privately owned lands in the county are concentrated on the valley floor of Jackson Hole south of Grand Teton National Park, an area approximately 20 miles long and up to 10 miles wide. There are 160 acres of private holdings within the National Elk Refuge (personal communication, M. Hedrick, Refuge Manager, USFWS, Jackson, Wyoming, August 27, 1992/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). There are significant areas of private holdings in Grand Teton National Park. Most of the private lands within Jackson Hole have not been intensively developed, although there has been rural-to-urban land conversion over approximately the past 3 decades. Ranching has declined considerably as an economic activity, but much of the former ranch land remains mainly in agricultural or woodland use. The vast majority of private land in Teton County has been classified as agricultural land in the past and continues to be. In 1954, there were 98 farms in Teton County comprising 72,724 acres. The U.S. Bureau of the Census 1989 reported 110 farms with a total of 72,197 acres within the county in 1987 (Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994).

This proposed environmental restoration project would occur upon privately owned lands and lands administered by the BLM. Lands would be altered through the removal of gravel and placement of materials to construct the environmental restoration tools. These alterations, however, would not eliminate any current land uses identified above or introduce any new land uses. The local sponsor would obtain real estate instruments, which the sponsor identifies in their real estate report as being necessary for implementation of environmental restoration work on Federal and private lands.

6.6 TRANSPORTATION

Several highway routes provide year-round transportation in the vicinity of the environmental restoration project. The primary route used by north and southbound traffic is U.S. Highway 26. The highway enters the Jackson Hole area from the northeast, continues through the valley and the community of Jackson, Wyoming, and exits the valley to the south. Wyoming State Highway 22 starts on the west side of Jackson, crosses the Snake River at the Wilson Bridge, and continues west over Teton Pass. Wyoming State Highway 390 extends north from its intersection with State Highway 22 near Wilson Bridge and is a primary route used by north and southbound traffic on the west side of the valley. Several secondary roads also provide access in and around the project area. These include, but are not limited to, South Park Loop, Fall Creek Road, and Spring Gultch Road. Various unnamed private roads exist in and around the project area.

Impacts upon transportation would occur as a result of construction of the environmental restoration project and subsequent performance of work to maintain the structures. Both construction and maintenance would require similar measures to implement. However, maintenance would likely involve less effort than actual construction; therefore, potential impacts from maintenance should be less than those of construction activities.

The transport of construction materials and supplies to the four project areas would increase truck traffic on primary highway routes and secondary roads. Trip repetitions for this type of traffic would generally be limited; therefore, any impact upon traffic patterns from this particular truck activity is expected to be minimal.

The ingress and egress of gravel trucks between gravel screening sites and upland disposal areas at existing gravel processing facilities would likely generate the greatest traffic increase on primary and secondary roads. Because the quantity of gravel that may be transported would reasonably vary from site to site and from year to year, establishment of an estimate for the number of repetitions necessary to perform construction and maintenance is difficult. It is reasonable to expect peaks in truck traffic that would add to or create traffic congestion. Conflicts may exist between contractors performing maintenance of the Jackson Hole Flood Control Project and contractors constructing the environmental restoration project. The

Corps would address such conflicts that occur on the Jackson Hole Flood Control Project access roads and levees. The local sponsor would identify any transportation conflicts on public roads and implement traffic control measures (such as flaggers or signage) at locations that experience more than minimal increases in traffic congestion. Operation of loaded trucks on the Jackson Hole Flood Control Project levees and access roads during construction and maintenance would likely cause impacts to the surface of these structures. The Corps would ensure repair of such surface impacts resulting from construction. The local sponsor would be responsible for repairs to the surface resulting from their post-construction maintenance activities. Because surface repairs would be implemented, impacts upon the access roads and levees would be temporary.

Staging areas for fuel and lubricant storage and dispensing would be located outside of the leveed sections of the Snake River. Staging outside the levees would dramatically decrease the potential for unintentional releases of toxic materials into the Snake River. A minimum of one staging area would be necessary at each of the four work areas. Staging areas would be selected and any easements, licenses, or permits necessary for staging areas would be acquired by the local sponsor. The contractor and any subcontractors would be required to submit for approval, prior to initiation of construction, a hazardous materials spill and cleanup plan including tools and materials that would be on hand and readily available to facilitate containment and cleanup. All overnight equipment storage, as well as refueling and maintenance activities, would be restricted to staging areas. Based upon the above measures, no more than minimal, short-term impacts upon transportation are expected from either maintenance or construction of the environmental restoration project.

Access to work areas would occur primarily upon the roadways identified below, in addition to other unnamed roadways. Access would generally originate from public roadways and may use roadways already under easement for access to the levees for the purpose of performing operation and maintenance activities. Real estate instruments necessary for access will be identified in the local sponsor's real estate report. The local sponsor would coordinate acquisition of necessary real estate instruments.

The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river would be necessary. The contractor would coordinate with the Corps' biologist, representative for the flood control project, and the landowner (in the field) to determine the optimum access routes for minimizing disturbances. The east and west access points for each of the 4 areas is described below.

6.6.1 Area 1 East Access

The east portion of Area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment would follow the levee until it terminates. After the levee ends, access would continue through existing shrubs and trees and over gravel bars.

6.6.2 Area 1 West Access

The west portion of Area 1 would be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to the Sewell Levee. It would then continue along the Sewell Levee to the work area. The access to the upstream work area would also originate from Fall Creek Road and would follow a dirt road to the work area.

6.6.3 Area 4 East Access

The east portion of Area 4 would be accessed from the Federal Levee Extension. Construction equipment would leave the public highway, approximately 4 miles to the north and follow the left bank of the Federal Levee Extension to the work area.

6.6.4 Area 4 West Access

Access to Area 4 would be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates at the channel bottom. The contractor may need to navigate across gravel bars and around existing vegetation.

6.6.5 Area 9 East Access

Access to the east portion of Area 9 would be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, an access point to the specific work areas would be selected in the field.

6.6.6 Area 9 West Access

Area 9 is the most accessible of the four areas. Access for the west portion of Area 9 would originate from State Highway 390. From State Highway 390, the contractors would follow an existing dirt road to the Right Bank Federal Levee.

6.6.7 Area 10 East Access

The work on the east portion of Area 10 would be reached from the downstream direction or the upstream direction. From the downstream direction, equipment would travel from State Highway 22 and then up the Left Bank Federal Levee for

approximately 3 miles to the work areas. From the upstream direction, equipment would travel from Cattleman's Bridge, which is approximately 2 miles away, to the Hanson Levee. The spur dikes located to the north would be accessed from Spring Gultch Road, which is about 2 miles away.

6.6.8 Area 10 West Access

Most of the work in Area 10 lies to the west of the river and would be accessed via the Right Bank Federal Levee. From the levee, construction equipment would traverse existing gravel bars and around or through vegetated areas to the specific work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee would be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

6.7 SOCIO-ECONOMICS

The Snake River and its tributaries have been an important resource in the economic and social development of the Jackson Hole area. A study of the economic importance of fishing to Jackson Hole is in effect a study of two of the states most outstanding resources: (1) the Snake River and its system of associated smaller rivers and creeks, and (2) the cutthroat trout. The decision to "go fishing" creates demands for goods and services.

The Jackson Hole area has become the summer home and vacation home destination for a number of families since 1970. Expenditures by these families in the Jackson Hole area, like tourist expenditures, represent a new demand for goods and services and a flow of new money into the local economy.

A Chamber of Commerce study (1985) was targeted at tourists visiting the area regardless of whether the party was from out-of-state or from another county in Wyoming. The results of this study indicated that the direct fishing related expenditures of $6,967,000 brought nearly $61,000,000 of "new money" into the area. The $61,000,000 total output relates to the direct, indirect (related industry output), and induced spending (household spending generated from the direct and indirect industry spending). This concept is called the "multiplier effect." The multiplier in this case is 8.9. This means that every dollar of direct spending generates $8.90 of total output throughout the local economy. Examples of related output may be local motel, eating establishments, and any other incidental expenditures the nonlocal may make while recreating and fishing in the area.

Translating these 1985 base numbers into current 1998 price levels using local inflation rate of 6.8 percent per year yields the following results. Direct fishing related expenditures at 1998 price levels are expected to be $16,386,000 [1985-1998 = 13 years @ 6.8 percent per year inflation (includes both money inflation of

4.05 percent and population growth of 2.7 percent) with gross receipts of $143,300,000 in local related industries].

The Jackson Hole, Wyoming, Environmental Restoration Project. studies four sites along the Snake River that are expected to yield the most benefit to the riparian and aquatic habitat. Assuming all four site alternatives are implemented and comparing the resulting benefits in aquatic and riparian habitat units, the Corps speculates that over the 50-year project period average annual fish numbers (cutthroat trout and other species) will help maintain their present population. Without the environmental restoration project, aquatic and riparian habitat will be expected to decline over the next 50 years.

The environmental restoration project, by improving the aquatic and riparian habitat, is also expected to enhance the aesthetics of the area to visiting sports persons and tourists, in general, regardless of their objectives in visiting the Jackson Hole area. By increasing the amount of vegetation in some areas, people may have a better experience when they go fishing. Most fishermen probably would rather see trees and other vegetation than bare cobble and gravel.

Local jobs maintained by the $143,000,000 output related to sportsfishing, accounts for about 25 percent of the total employment of Teton County. This is based on statistics furnished by the Jackson Hole Economic Development Council web site. Local nonfarm sales in 1997 were estimated at $583,000,000 based on sales tax receipts of $35,000,000 in this sector. The sales tax rate of 6 percent would indicate gross sales of $583,000,000. Approximately 18,500 workers generated this $583,000,000 in sales. This allows each worker to generate $31,600 sales per year. If the $143,000,000 sportsfishing output and sales is maintained, 4,500 jobs would be enhanced in the area. No consideration was given to the cost of each option since those numbers are not available at this time.

6.8 RECREATION

The Snake River in the vicinity of the four project areas principally experiences recreational use from rafting and fishing. Some waterfowl hunting also occurs on the river. Levees along the four project areas are used for a variety of recreational purposes including walking, hiking, jogging, bicycling, cross country skiing, horseback riding, bird watching, nature viewing, picnicking, and other similar uses. The levees also provide access for direct river use such as fishing and waterfowl hunting.

The majority of recreational use for the four project areas occurs near the Highway 22 Bridge (Area 9), also known as the Wilson Bridge. Recreational use at this site occurs year-round, with high use continuing into November. South Park Elk Feed Grounds receives limited public recreational use, most of which occurs during summer as hiking and nature viewing (personal communication, Tim Young, Jackson Hole Community Pathways, November 1998). The southwest levee at

Wilson Bridge experiences considerable use. The northwest levee gets only limited use while the southeast levee does not get any use. The northeast levee gets a lot of use due to the close proximity of a park (personal communication, Franz Carmindzend, Jackson Hole Alliance, October 1998).

A 1990 report filed by the WGFD, Jackson Field Office, indicated that during the summer months, the Wilson Bridge site experienced 2,313 user days by fishermen using the upper stretch and 1,804 user days on the lower end. A precise count for 1998 is not currently available. It is likely the area experiences the same or slightly higher levels of use than 1990.

Camping on islands and on shore sites is prohibited by the settlement of a lawsuit between the BLM and landowners. With the landowners in control of how the land is used in the proposed project reach, many recreational restrictions exist. Camping is one of the recreational uses that is prohibited in all but one or two sites. These sites are very rarely used.

The proposed action has the potential for both short-term and long-term impacts upon recreational uses. Recreational use could potentially be affected by construction, impacts from the presence of completed structures, and impacts from structure maintenance.

The effects of construction activity would occur principally in the form of short-term impacts. These impacts would occur during ingress and egress of equipment to the work sites and during actual on-site construction. Access to the work sites would occur over a variety of routes and for a variety of purposes. Access would be necessary to transport equipment, materials, and supplies to and from the work sites. Some routes would require use of levees and others would not. Of the levees that would be used for ingress and egress, some receive recreational use and others do not. Those that receive recreational use have the potential for user conflicts to develop.

Use of the Sewell and Lower Imenson Levees would be necessary to access Area 1. The public does not have access to either of these levees. The Federal Levee Extension would be used to access the east side of Area 4. There is no public access to the Federal Levee Extension at the east side of Area 4. The Right Bank Federal Levee would be used to access the west side and the Left Bank Federal Levee used to access the east side of Area 9. Access to reach the Left Bank Federal Levee on the east side at Area 9 would be through an existing conservation park used by recreationists. Access to the Right Bank Federal Levee at Area 9 would occur upon an existing unpaved road leading to a boat launch and parking area. The public has access to both the Right and Left Bank Federal Levees at Area 9. Area 10 would be accessed via the Right Bank Federal Levee on the west and the Left Bank Federal and Hanson Levees on the east. There is no public access to levees at Area 10.

Operation of equipment upon levees accessible to the public would create a conflict for persons hiking or walking the levee. As indicated above, traffic control measures, such as flaggers or signage, would be used at locations that would experience more than minimal conflicts between recreationists and construction-related activity. Such situations would be identified and resolution measures implemented by the local sponsor. Impacts from construction-related activity upon levee users would be temporary and would be minimized through the use of measures referenced above.

Gravel removal to maintain channel capacity and construct channel stabilization pools would occur in areas of the primary river channel. In-channel work may also involve construction of temporary water diversions or berms to reroute flows and de-water gravel removal sites. Spur dikes would be constructed adjacent to levees where the high-velocity flows of the primary channel occur. Rafters and float fishermen would be the primary recreationists likely to be affected by the in-channel work. Fishermen fishing from the bank or wading would be less affected. The primary effect upon rafters and float fishermen would occur from the temporary alternation of the primary channel flow. The proposed gravel removal would have only a minor effect upon rafters and float fishermen.

Presence of completed eco fences, channel stabilization pools, anchored root wad logs, and spur dikes would change the configuration of the river channel and effect flow patterns. Eco fences, anchored root wad logs, and spur dikes would result in more permanent changes to the channel than would the channel stabilization pools. Channel stabilization pools would trap bedload materials, therefore, would become less prominent over time. However, maintenance of the channel stabilization pools after they have filled with bedload material would result in renewed changes in configuration and flows.

Permanent changes in the channel are expected to have long-term, yet minimal impacts upon rafters and float fishermen. Rafters would have to become accustomed to the new configuration and flows resulting from spur dikes, anchored root wad logs and eco fences. Because these structures would not be in the middle of the primary flow, rafters and float fishermen should have little difficulty negotiating or bypassing the structures. The effort required for rafters and float fishermen to learn the new changes are expected to be no greater than is required each year after seasonal high flows. The permanent changes in configuration and flow would not de-water the channel or restrict access. The permanent changes have considerable potential to provide long-term benefits to recreational users through the creation of additional fish habitat.

If structures are damaged by high flows, parts of structures, such as cables from eco fences, could pose a hazard to rafters and float fishermen. To alert river users to the presence of the new structures, the local sponsor would implement a public information campaign and perform monitoring and maintenance to identify potentially unsafe structure conditions.

Gravel removal to maintain channel capacity and construct channel stabilization pools is expected to have even less impact on recreationists than the eco fences, channel stabilization pools, anchored root wad logs, and spur dikes. Channel stabilization pools would cause slower flows, creating a pool effect, therefore, would not pose as a hazard or barrier to floaters. This change is not expected to have more than a minimal effect on rafters and float fishermen. Floaters and rafters would likely experience improved floating conditions due to stabilization of the channel. Overall, the permanent, long-term effects upon recreation resulting from the presence of the completed structures are expected to be minor.

The effects of maintenance upon recreation activities would be similar to those resulting from construction. However, work required to perform maintenance is reasonably expected to be less than would be required to actually construct the environmental restoration project. Primary effects would result from ingress and egress of equipment and actual construction activity and would be short-term.

Levees at Area 9 actively being used in support of construction would be clearly signed at all access points to alert users to the presence of trucks and other equipment. Because the greatest use by recreationists occurs on the Left and Right Bank Federal Levees upstream of the Wilson Bridge at Area 9, the greatest inconvenience upon recreationists would likely occur at these locations.

A flagger would be posted, when necessary, at the Area 9 boat ramp to coordinate use between recreationists and construction equipment using the site for ingress and egress to construction areas.

A public information campaign would be implemented by the local sponsor to inform the recreating public about the environmental restoration project and possible conflicts between recreationists and construction activities. The campaign would include installation of appropriate signage at all levee access points and at the ramp and conservation park at Area 9. An information brochure would be prepared and distributed by the local sponsor to all fishing and rafting outfitters as well as placed at information boards at public access areas. Other sources available to the local sponsor for distributing information to the public may include the print media and radio. The campaign would be implemented both prior to and during construction.

6.9 AESTHETICS

The proposed environmental restoration project would occur within the Snake River between the levees near the Jackson Hole, Wyoming, area. The Jackson Hole area is popular as a year-around recreation destination. The area's spectacular scenery is of national significance, as evidenced by the establishment of the Grand Teton National Park in 1929.

The proposed environmental restoration project areas are located in the outwash plain of the Snake River. The river channel is relatively wide and braided with

extensive areas of gravel bars. Riparian vegetation is found along many of the channels. Stands of trees, composed primarily of cottonwoods, willow, and alder are scattered throughout the outwash plain.

Views of the floodplain, by boaters and other recreationists using the Snake River, are generally restricted because of adjacent riverbanks, levees, and vegetation. The primary views along the rivers are of the mountains, particularly the Grand Teton Mountains, which can be viewed beyond the riverbanks and levees in locations where there are openings in the riparian vegetation.

Within the past few years, Area 1 has undergone extensive lateral erosion due to the "fire hose" effect of concentrated river flows emerging from the confined channel upstream. The installation of eco fences and anchored root wads would help to reestablish island vegetation as well as help protect existing islands and encourage growth of new islands.

The vegetation at Area 4 is predominately shrub-willow. Most of the existing islands currently within the channel are devoid of vegetation due to island instability and changing river flows. The installation of eco fences and anchored root wad logs would help reestablish island vegetation.

The river at Area 9 is somewhat restricted and the islands are devoid of vegetation. The vegetation along the shoreline is predominantly shrub-willow. Rock grade control structures would be constructed flush with the existing channel bottom and would help prevent bank erosion and degradation of existing habitat. Eco fences and anchored root wad logs would assist in revegetation of existing islands and establishment of new islands. Spur dikes would be used to provide bank protection and enhance fisheries habitat by creating flow diversity and enhancing pools, fish resting areas and riffles, thus improving the visual quality of the riverbanks.

Area 10 is located at the confluence of the Gros Ventre and Snake Rivers. This area has extensive cottonwood vegetation on existing islands and along the shoreline. Eco fences and anchored root wad logs would assist in promoting a more diverse vegetative cover along existing shorelines and encourage the growth of new islands. Spur dikes would enhance fish habitat and provide additional bank protection. This would allow regeneration of native plants as well as improve the visual quality of the riverbanks.

The removal of gravel to maintain channel capacity and construct channel stabilization pools and the presence of the anchored root wad logs, eco fences, off-channel pools, and secondary channels are not expected to contrast sharply with the existing surroundings. The proposed measures are expected to create long-term potential for restoring aquatic and terrestrial habitat along the environmental restoration project area. Over time, with the reestablishment of islands and vegetation, the aesthetics of the project area would improve.

6.10 CULTURAL RESOURCES

The area of the proposed environmental restoration project includes floodplain areas between the levees along the Snake River. This area is part of the glacial outwash plain that forms the floor of the area referred to as Jackson Hole. The surface has been modified by fluvial deposition and erosion caused by the Snake River and its tributaries. Soils are generally deep, loamy soil types with a high proportion of rock fragments. Stream crossing locations typically exhibit river cobbles or gravel with some sandy soil cover. The valley floor is interrupted in places by ridges and buttes, formed by remnant volcanic and intrusive rocks.

A Class 2 reconnaissance survey was performed within the generalized environmental restoration project areas during the period August 12 to 16, 1996, by the Walla Walla District's staff archaeologist. Record searches were also conducted. No previously unrecorded cultural properties were found during the reconnaissance survey. Record searches identified two previously recorded sites close to two of the proposed environmental restoration project areas but outside of the levees.

Because the previously recorded sites are located outside of the levees, away from where the proposed actions would occur, the Corps determined the environmental restoration project would have no effect on any previously listed cultural property. The Corps also determined the potential for the occurrence of any unrecorded cultural properties in the areas of impact to be low.

A copy of the Corps' Survey Report was forwarded to the Wyoming Division of Cultural Resources, State Historic Preservation Office (SHPO), for review and concurrence. In their letter of February 12, 1997, the SHPO responded that no sites meeting the criteria of eligibility for the National Register of Historic Places would be affected by the environmental restoration project. The SHPO recommended the project proceed in accordance with state and Federal laws, subject to the following stipulation: "If any cultural materials are discovered during construction, work in the area should halt immediately and the Corps and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken." Refer to appendix D for the SHPO letter concurring with the Corps' determination of "no effect."

6.11 CUMULATIVE EFFECTS

The Flood Control Act of 1950 authorized flood protection by levees and revetment along the Snake River in the Jackson Hole, Wyoming, area. The project was completed in the fall of 1964. Levees have been added to the system by other agencies and by "emergency flood fight" operations of the Corps and Teton County through 1997. The effect of these measures has been the alteration of the physical character of the river, both inside and outside of the levees, along approximately 25 miles between Moose Bridge and South Park Elk Feed Grounds. Presently, the

width of the Snake River floodplain is reduced by the levees, flow velocities through the leveed sections are increased, elevated quantities of bedload material is transported through the area, and island and associated vegetation is eroding. Water flows to spring creeks outside of the levees have been reduced. Spawning habitat for cutthroat trout has been reduced or destroyed and the composition and quality of riparian vegetation outside of the levees is changing.

During the winter of 1998-99, Teton County coordinated a demonstration project within this same stretch of river near the Wilson Bridge. Approximately 6,000 cubic yards of cobble and gravel were excavated to construct three off-channel pools. Approximately 1,600 linear feet of channel was excavated to maintain flow capacity within 100-year event flows. Five-pile eco fences totaling approximately 500 linear feet were also constructed. The purpose of the demonstration project was to implement measures to counteract the adverse resource effects of the existing levees and revetment. Effects of the demonstration project would be the long-term improvement of water quality, stabilization of the channel, and establishment of aquatic and terrestrial habitat.

During the same period, Teton County also constructed a kicker along the left bank of the river just above the Wilson Bridge to diminish effects of flows on the levee. This work was conducted in accordance with a Local Cooperation Agreement signed by the Corps and Teton County in September 1990 for the performance of levee maintenance. Teton County conducts annual operations to maintain the levees; however, the maintenance operations do not increase or expand effects to the existing levees and revetment on the Snake River.

The environmental restoration measures being proposed under the Jackson Hole, Environmental Restoration Project, would have both short- and long-term effects on the Snake River. Environmental restoration measures proposed for Area 1 include excavation of a single channel stabilization pool and four off-channel pools with connecting upstream and downstream secondary channels, construction of eco fences, and placement of anchored root wad logs. Construction would result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures would have long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat. The changes attributable to the collective effect of actions proposed for Area 1 would decrease nonbeneficial effects of past flood control activities and cause an overall net increase in beneficial effects in the long-term. There would be no measurable increase in the baseline detrimental effects caused by previous flood control activities.

Environmental restoration measures in Area 4 would include: excavation of two channel stabilization pools and three off-channel pools with connecting upstream and downstream secondary channels; construction of eco fences and spur dikes; placement of anchored root wad logs; and removal of gravel to maintain channel

flow capacity within 100-year event flows. Construction would result in minor, non-beneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. The completed structures would cause long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat by stabilizing the channel and allowing recovery of aquatic and terrestrial habitat. Actions proposed in Area 4 would not add to the cumulative adverse effects caused by previous flood control actions at Area 4.

Environmental restoration measures in Area 9 would include: construction of eco fences, placement of anchored root wad logs, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction would result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures in Area 9 would result in long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat. The changes attributable to the collective effect of actions proposed for Area 9 would decrease nonbeneficial effects of past flood control activities and cause an overall net increase in beneficial effects in the long-term. No measurable increases in the net detrimental effects caused by previous flood control activities would occur.

Environmental restoration measures in Area 10 would involve excavation of a single channel stabilization pool and two off-channel pools with connecting upstream and downstream secondary channels, construction of eco fences, placement of anchored root wad logs, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction in Area 10 would also cause minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Water quality, recreation and aquatic and terrestrial habitat would benefit in the long-term from the presence of the completed structures. Changes caused by the cumulative effect of actions proposed for Area 10 would cause the nonbeneficial effects from past flood control activities to diminish. In the long-term, an overall net beneficial increase in aquatic and terrestrial habitat would occur.

The cumulative effect of past and proposed actions along the Snake River would not cause additional reduction in the width of the floodplain, increase flow velocities through the levied areas, increase transport of bedload material, destabilize the channel, erode islands and vegetation between the levees, or diminished flows to spring creeks outside of the levees. The cumulative effect of the proposed environmental restoration project would be improved water quality through reduced velocities and stabilization of the channel, reduced erosion of islands and loss of vegetation, opportunity for the reestablishment of islands and vegetation, and creation of additional habitat for cutthroat trout and other aquatic and terrestrial species.

7.0 COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND REGULATIONS

The following paragraphs address the principal environmental review and consultation requirements applicable to this environmental restoration project. Pertinent Federal statutes, executive orders, and state permits are included.

7.1 FEDERAL STATUTES

7.1.1 National Historic Preservation Act, As Amended; Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971

The proposed action was evaluated for compliance with the above Act and Executive Order; and a report was coordinated with the Wyoming Department of Cultural Resources, SHPO. The SHPO concurred that no sites meeting the criteria of eligibility for the National Register of Historic Places would be affected by the proposed action. This environmental restoration project would, therefore, be in compliance with the Act and the Executive Order.

7.1.2 Clean Air Act, As Amended

Construction activities would result in only minor, short-term exhaust emission from construction equipment. Fugitive dust from this environmental restoration project would also be minimal. This project would be in compliance with the Clean Air Act.

7.1.3 Clean Water Act

Section 404 of the Clean Water Act [33 United States Code 1344] requires evaluation of activities involving discharges of dredged or fill material into waters of the United States, including wetlands. The 404(b)(1) Guidelines [40 Code of Federal Regulations (CFR) Part 230] are the substantive criteria used in evaluating discharges of dredged or fill material under the Act. The Corps has prepared an evaluation (appendix E) of discharges associated with the environmental restoration project, in accordance with the Guidelines. The evaluation will be used to solicit water quality certification from the State of Wyoming, DEQ. The Corps would not initiate discharges in the Snake River until the environmental restoration project has been certified or conditionally certified.

7.1.4 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1958 (Public Law 85-624) requires that when the water of a stream or other body of water are proposed to be impounded, diverted, channel deepened, or stream or other body of water otherwise controlled or modified for any purpose, the USFWS be consulted. The USFWS was tasked with writing a CAR. The CAR was completed, reviewed by the Corps, and finalized on

October 27, 1998. See appendix B. This environmental restoration project is in compliance with the Act.

7.1.5 Endangered Species Act of 1973, As Amended

A list of threatened or endangered species that might occur in the vicinity of the environmental restoration project was obtained from the USFWS. The Corps prepared a BA of potential effects of the project upon the listed species. In their letter of November 30, 1998, the USFWS responded that the project may affect, but would not likely adversely affect, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf. See appendix A.

Based on the above, this environmental restoration project would be in compliance with the Act. However, construction is not scheduled to begin until 2001 and only one area would be constructed each year between 2001 and 2004. If construction is not begun within 180 days of the date the above species list was issued, a new species list must be obtained and a review of the BA completed. If construction is implemented in accordance with the above schedule, a new species list and review of the BA would be required prior to each year of the proposed 4-year construction phase.

7.1.6 The NEPA

This EA has been prepared pursuant to requirements of the Act. No significant impacts have been identified at this time. If no significant impact is identified during the public review process, an EIS would not be required. If an EIS is not required, full compliance with NEPA would be achieved upon the signing of a Finding of No Significant Impact (FONSI).

7.1.7 Wild and Scenic Rivers Act

This segment of the Snake River is not included on the inventory of wild and scenic rivers. (National Wild and Scenic Rivers System, December 1992 and its 1997 updates, published by Department of the Interior and the Department of Agriculture, Forest Service.)

7.1.8 Migratory Bird Treaty Act

The environmental restoration work would be performed in such a manner that migratory birds or their habitat would not be harmed or harassed. The proposed work would be performed outside of the major nesting season for most birds. Bird species that nest later in the summer, such as the American goldfinch (*Carduelis tristis),* may be impacted by noise and activity associated with construction and gravel sorting. The proposed action does not involve the removal of mature trees that may be used for nesting by bird species protected by this act. Some brush and small trees would be damaged or removed during construction of side channels and

pools. If there are no bald eagles nests found within 1 mile of the environmental restoration project area, work may begin earlier than August 15 after consultation with the USFWS. This consultation is necessary to ensure no other nesting migratory birds would be impacted by the construction activity.

7.2 EXECUTIVE ORDERS

7.2.1 Executive Order 11988, Floodplain Management, May 24, 1977

The use of structures such as eco fences, spur dikes, and anchored root wad logs for restoration purposes necessitates their construction within the 100-year flood profile. However, such environmental restoration measures would not directly or indirectly support development in the base floodplain. Most of the channel modifications would fall within the regulatory floodway as delineated by the Federal Emergency Management Agency in their May 4, 1989, Teton County Flood Insurance Study (FIS). The area is designated as a no-rise area, meaning that actions within or adjacent to the floodway should not result in a rise in the regulatory, 100-year flood water-surface profile.

To assist in assessing the potential for a reduction in the base floodplain, hydraulic modeling of the Snake River in each of the study areas was performed using HEC-2, a computer-based backwater model developed by the U.S. Army HEC. In Area 1, comparison of the profiles with and without the environmental restoration measures indicates that the environmental restoration project would result in lowering the water surface profile up to about 1 foot in the excavated areas. The environmental restoration measures in this area are not expected to result in a rise in the 100-year flood profile.

At Area 4, the proposed environmental restoration measures would lower the existing profile (1996) at or below the regulatory level for all areas within the environmental restoration area. Based on observed water surface profiles at Area 9, along with results of the hydraulic modeling, it does not appear the environmental restoration measures would result in any rise above the regulatory 100-year profile. For Area 10, the restored channel profiles would be below the 100-year profile.

The proposed action would not decrease the base floodplain or support development in the floodplain. Based on these findings, the environmental restoration project would be in compliance with the Order.

7.2.2. Executive Order 11990, Protection of Wetlands, May 24, 1977

The proposed action is intended to restore and protect riparian and wetland habitat. The proposed environmental restoration tools would be strategically placed to prevent erosion of riparian and wetland areas and to facilitate conditions suitable for wetland development. The proposed action would not support new construction in wetlands.

The contractor would coordinate with the Corps' biologist, representative for the (Jackson Hole) flood control project, and the landowner (in the field) to determine the optimum access routes and locations for structure placement to avoid (to the extent possible) impacts to existing wetlands. The proposed action would be in compliance with the Order.

7.3 STATE PERMITS

No permits are required from the State of Wyoming at this time. If, however, the State of Wyoming determines during their review of this EA that a permit is required, the local sponsor would take appropriate action to apply for and obtain the necessary permits prior to the start of construction.

7.4 ADDITIONAL REQUIREMENTS

A Temporary Gravel Extraction and Processing Permit must be obtained pursuant to Teton County Land Development Regulation. The local sponsor would apply for the permit through the Teton County Planning Department prior to the start of construction.

A permit must be obtained from the BLM prior to initiation of gravel removal from lands administered by that agency. The local sponsor would obtain the permit.

7.4.1 Noise Standards, 24 CFR 51 B

Noise would occur principally in association with truck transportation of materials and supplies, operation of excavation equipment, operation of equipment to screen cobbles, and operation of jackhammers for installation of root wad lag anchors.

Noise generated on site by the environmental restoration project would be experienced primarily by recreational users in the vicinity of construction areas. Most of the lands along the river segment are undeveloped. Public access to the project areas is primarily limited to levees extending upstream and downstream of Wilson Bridge near Area 9; therefore, most impacts of on-site noise will be concentrated around Area 9. Access to other areas of the project would occur by private landowners or by rafters or floaters. Rafters and floaters would be exposed to the increased noise levels when passing through the construction area. Truck traffic noise would be experienced by travelers on roadways being used for ingress and egress to active construction sites. Gravel removal and processing activities in the vicinity of Area 9 contribute to the existing background noise.

Increased noise levels would be restricted to daylight hours. Any increases in noise levels beyond existing background levels would be short-term.

7.4.2 The CEQ Memorandum, August 11, 1990, Analysis of Impacts of Prime or Unique Agricultural Lands in Implementing NEPA

No prime or unique farmland would be adversely impacted by construction. Access routes are not expected to cross farmlands. The environmental restoration project areas are all within the floodway. Many are bound by existing levees.

8.0 COORDINATION

This environmental restoration project has been coordinated with applicable agencies including USFWS, USFS, U.S. Environmental Protection Agency, BLM, Natural Resources Conservation Service, WGFD, Wyoming DEQ, Wyoming Division of Cultural Resources SHPO, and Wyoming Department of Transportation. Additionally, this EA has been distributed to interested members of the public for their review and comment.

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APPENDIX A

BIOLOGICAL ASSESSMENT
AND
ENDANGERED SPECIES ACT SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

ES-61411
pd/W.06/wy2055.pd

November 30, 1998

Mr. Peter F. Poolman
Chief, Environmental Compliance Branch
U.S. Army Corps of Engineers
Walla Walla District
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Poolman:

Thank you for the Biological Assessment for the Jackson Hole Environmental Restoration Project, Snake River, Teton County, Wyoming received by our office on October 26, 1998.

Based on the information provided in the Biological Assessment, and a fax tramission from Mr. Scott Ackerman of your staff dated November 30, 1998, we concur with your assessment that the project, as described, may affect, but is not likely to adversely affect the threatened bald eagle (*Hailieetus leucocephalus*), peregrine falcon (*Falco peregrinus*), whooping crane (*Grus americana*), grizzly bear (*Ursus arctos*) and gray wolf (*Canis lupus*). However, if the scope of the project is changed, or the project is modified, in a manner that you determine may affect a listed species, this office should be contacted to discuss consultation requirements pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended.

We appreciate your efforts to ensure the conservation of endangered, threatened and candidate species. If you have further questions on this subject, please contact Pat Deibert of my staff at the letterhead address or phone (307) 772-2374, extension 26.

Sincerely,

Michael M. Long

Michael M. Long
Field Supervisor
Wyoming Field Office

Mr. Peter Poolman
U.S. Army Corps of Engineers

cc: Director, WGFD, Cheyenne, WY
Nongame Coordinator, WGFD, Lander, WY

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WASHINGTON 99362-1876

Reply To
Attention Of:

October 19, 1998

Planning Division

Mr. Michael Long, Field Supervisor
Wyoming Field Office
U.S. Fish and Wildlife Service
Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

Dear Mr. Long:

Pursuant to Section 7(c) of the Endangered Species Act, we request your review and informal consultation on the proposed project as described below and concurrence on our *"May Affect But Is Not Likely To Adversely Affect"* determination.

Project Title

Jackson Hole Environmental Restoration Project, Snake River, Teton County, Wyoming

Project Purpose, Location, and Actions

Purpose

The following synopsis was derived from Appendix B Engineering (Draft) from the "Jackson Hole, Wyoming, Environmental Restoration Feasibility Study" which has already been received by your office. This synopsis does reflect some minor changes which were added after Pat Deibert received and commented on the initial draft of this document.

The purpose of the Jackson Hole, Wyoming, Environmental Restoration Project is to improve riparian and riverine habitats which have degraded over the years. The Snake River, in this area, is confined by levees that concentrate the river flows causing excessive erosion of existing vegetation and wildlife habitat.

In an effort to protect the remaining vegetation and encourage growth of new vegetation, several tools for protection and environmental restoration were developed in this study.

Location

The proposed work area is located on the Snake River near the towns of Wilson and Jackson in Teton County, Wyoming. Area 1 is located in sections 13, 14, 23 and 24, Township 40N, Range 117W. Area 4 is located in sections 2, 3, 10 and 11, Township 40N, Range 117W. Area 9 is located in sections 13, and 24, Township 41N, Range 117W. Area 10 is located in sections 5, 6, and 7, Township 41N, Range 117W.

Tools for Restoration

The project involves five restoration tools that were adopted from other river restoration projects. Due to the extreme nature of river conditions, each restoration tool was designed to withstand high-river forces. The restoration tools consist of gravel removal, brush fences, anchored root wad logs, rock grade control, and spur dikes.

a. Gravel Removal

The functions for gravel removal consist of improving fish habitat, maintaining channel capacity, increasing channel stability, and improving sediment transport. Three different gravel removal tools would be used to perform these functions. They include channel capacity excavations, side pools, and sediment traps.

(1) Channel Capacity Excavations

One of the primary objectives of the project is to increase the vegetation between the levees. If this objective is achieved, then the flow capacity of the river will diminish. In order to maintain the current flow capacity, it would be necessary to remove some of the existing riverbed material. The removal of riverbed material would be accomplished with channel capacity excavations, which would be needed in areas 4, 9, and 10. No channel capacity excavations are planned for area 1. Area 1 currently has a very large flow capacity and has room to allow for the projected growth of vegetation without creating a potential flood hazard.

Channel capacity excavations would be designed to maintain the 100-year flood while considering the projected amount of vegetative growth between the levees. The amount of vegetation corresponds to the projected amount of channel blockage.

Excavations would vary in depth from 0 to 8 feet with an average depth below ground of 4 feet. Excavations would extend down to the adjacent thalweg.

In order to maintain channel bottom stability, the channel bottom would be armored with 4-inch-plus material obtained from the excavation. The armor material would be placed in rows spaced 10 feet apart on center aligning perpendicular to the channel centerline. The rows would have a cross-sectional area equivalent to 10-square feet. This would provide a volume of armor equivalent to a 1-foot-thick layer of armor on the channel bottom.

(2) Side Pools

Side pools would be excavated in the existing gravel bars to provide pools for fish habitat. The gravel bars are very expansive, generally up to 600 to 800 feet in width and devoid of vegetation. To minimize excavation, side pools would be sited in existing low-lying areas.

Pools would be excavated to provide approximately 4 feet of water depth during low flow. In order to create a natural appearance and to maximize wildlife benefits, the slopes of the pools would be varied. The upstream end of the pools would be protected with a 12-inch-thick layer of cobbles.

Supply channels would be needed to provide water to and from the side pools. Existing secondary channels would be cleared through excavation, as much as possible, to allow water to run to and egress from the pools. In areas where no secondary channel exists, new channels would be excavated. To add fish value, the depth of excavation would be varied from 1 to 4 feet below the low flow water line. The estimated average depth of these excavations is 1 foot with a bottom excavation width of 4 feet.

(3) Sediment Traps

Sediment traps would be excavated to catch bed load material, thereby, lessening downstream sediment deposition and maintaining the channel capacity. A secondary benefit would be improved fish habitat from the creation of a large pool.

Sediment traps would vary from 20 to 35 acres in surface area and would be excavated to the adjacent thalweg elevation. The depth of excavation generally varies from 2 to 6 feet with an average of 4 feet. The side slopes would be varied. The bottom of the sediment traps would be armored with 4-inch-plus cobble.

b. Brush Fences

Brush fences have two main purposes: reestablish island riparian habitat and protect existing island riparian habitat. Brush fences and woody debris placement would be used to slow water velocities and reduce energy impacting the islands. The intent of slowing the water velocities is to decrease island erosion and induce sedimentation to augment the island-building processes.

The brush fence tool was developed to collect floating woody debris to form a shield that would protect existing riparian zones and induce sedimentation downstream of the brush fence. The brush fences would be situated to protect islands with existing riparian habitat. They would also be situated along barren islands to increase sedimentation and vegetation growth.

There are two types of brush fence designs. One brush fence design consists of piling with lateral cables strung between the piling. The other brush fence design is constructed of riprap.

(1) Piling Brush Fences

Pipe (6 inch) and "H" pile (8x36 and 10x42 inches) would be used with wire rope to construct the piling brush fences.

(2) Rock Brush Fences

The purpose for considering a rock brush fence is to investigate an alternative to a piling fence that would be suitable for withstanding the high river forces. The rock brush fences would consist of riprap with side slopes of 2 horizontal to 1 vertical and an embedment depth of at least 4 feet below the adjacent ground line. Riprap would be placed to a top elevation of 1 foot below the 100-year flood.

c. Anchored Root Wad Logs

Root wad logs would be anchored to the river bottom. These two methods would be employed in their placement: staggered placement and scattered placement. Staggered placement would be used to protect existing islands and to encourage the growth of new islands. Whereas, scattered placement would be used to increase the amount of woody debris in the river system.

d. Rock Grade Control

A rock grade control structure would be used in area 9 to keep the river from eroding through existing riparian habitat. The rock grade control structure would consist of riprap. The top surface of the rock grade control structure would be flush with the existing channel bottom. Rock grade control structures may be constructed in other areas to prevent channel down-cutting.

e. Spur Dikes

Spur dikes would be situated along the levees for fisheries habitat enhancement and bank protection creating flow diversity that provides relatively slack water where steady current was found before.

There are two kinds of spur dikes under consideration, kickers and bank barbs. Kickers, which are the larger of the two, would be composed of riprap armor with a random fill core and extend approximately 56 feet into the river. Bank barbs would consist of only riprap and extend approximately 26 feet into the river. The larger size of the kicker would provide a scour hole at the end of the kicker and more slack water for fish habitat.

Construction

Due to the varying nature of site conditions, a Corps hydrologist and a Corps biologist would be on site to ensure that the project was constructed as planned. It is anticipated that the work would be contracted out through an equipment rental contract. Environmental stipulations will be addressed in this contract. Corps personnel will provide oversight of the ongoing work.

a. Gravel Removal

Work would be accomplished with excavators, loaders, dump trucks, and grizzlies. Depending on Wyoming State Department of Environmental Quality recommendations, construction equipment would not be operated in flowing water. In order to keep the equipment out of flowing water, it may be necessary to divert the water away from the excavations. This would be accomplished with diversion dikes and/or diversion channels. Diversion dikes would be constructed with existing riverbed material adjacent to the dike.

b. Piling Brush Fences

Piling brush fences would be constructed by first excavating out the high points along the fence alignments so that the bottom wire can be installed. Next, the piling would be driven to the required penetration depths with a backhoe mounted with a vibratory hammer. Holes would then be drilled through the piling to thread the wire rope through. At every fifth piling, a wire rope connection would be welded to the piling. After installation of the wire rope, trenches would be backfilled and compacted.

c. Rock Brush Fences

A trench along the alignment would be excavated to a depth of 4 feet below the adjacent ground line with an excavator. The trench would be wide enough to allow for the footprint of the structure. Material from the excavation would be hauled off site.

d. Anchored Root Wad Logs

Root wad logs, existing on site, would be used as much as possible to minimize the expense of hauling logs to the site. Logs would be transported to the site by truck, rubber-tired skidder, or helicopter. Specific source locations would be designated in the field by a Corps representative. Log removal will not be performed in areas where the action would promote excessive erosion or damage existing riparian vegetation.

A backhoe may be used to level out an area to place the logs so that the log would have uniform bearing along its trunk and its root would be partially embedded. The log would be fastened down with toggle bolt anchors. The anchors would be driven into the ground with a jackhammer and a jack would be used to pull up on the anchors locking them into place. The cable would be tied around the log and synched down to tighten the log to the ground.

e. Rock Grade Control

The footprint of the rock grade control structure would be excavated. Material resulting from the excavation would be hauled off site. Riprap would be placed in the excavation area by carefully keying the riprap together to minimize voids to form a locked mass.

f. Spur Dikes

The spur dikes, which include both kickers and barbs will be constructed with an excavator on the levee. Dump trucks would haul materials to the spur dike location along the top of the levees.

Construction Materials:

a. Riprap

The contractor would be responsible for selecting riprap sources that would provide the necessary quantity and quality of materials meeting the requirements. Riprap can only be obtained from a permitted quarry site. The contractor would be responsible for making arrangements with the quarry operators concerning availability of riprap. One potential source would be the quarry reject pile at Walton Quarry owned by the State of Wyoming. For more information regarding this site, contact Teton County. The contractor would comply with all applicable local, State, and Federal laws and regulations including, but not limited to, the Clean Water Act; Resource Conservation and Recovery Act; and Comprehensive Environmental Response, Compensation, and Liability Act.

b. Woody Debris

Woody debris would be obtained from on-site and off-site sources selected by the contractor. It is estimated that 3,000 root wad logs, acceptable for construction, are scattered along the river. An additional 200 root wad logs are piled at Walton Quarry. The woody debris available on site would be used first. Additional woody debris would be obtained off site. Other possible sources for off-site woody debris include Jackson Lake. Palisades reservoir can not be used as a site due to the presence of whirling disease. Because of the possibility of whiling disease in other areas, approval for root wad log acquisition sites will be made by U.S. Fish and Wildlife Service or Wyoming Game and Fish Department.

Root wad logs of deciduous and coniferous tree species would be acceptable. They would be at least 8 feet in length and no longer than 20 feet. The stem would be at least 12 inches in diameter and the roots would remain intact.

Construction Access

Access to the work areas will generally originate from the public highway system and traverse over existing easements to the levees. The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. For cost estimating purposes, it is assumed that gravel resulting from the excavations would be hauled 12 miles from each area.

Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river would be necessary. For convenience, the following describes the access points by the west access and the east access.

The sensitivity of some riparian areas will require some coordination to determine the best access route. A Corps biologist should be consulted as to the best access route through riparian vegetation so impacts to these areas can be minimized.

a. Area 1

(1) West Access

The west portion of area 1 would be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to Sewell Levee. It would then continue along Sewell Levee to the work area. The access to the upstream work area would also originate from Fall Creek Road and would follow a dirt road to the work area. This access will need to be determined in the field.

(2) East Access

The east portion of area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment would follow the levee until it terminates. After the levee ends, access would continue through existing shrubs and trees and over gravel bars. The contractor would coordinate with the Corps in the field to determine the optimum routes for minimizing disturbances.

b. Area 4

(1) West Access

Access to area 4 would be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates onto the channel bottom. The contractor would then navigate across gravel bars and around existing vegetation.

(2) East Access

The east portion of area 4 would be accessed from the Federal Levee Extension. Construction equipment would leave the public highway, approximately 4 miles to the north, and follow the left bank to the Federal Levee Extension to the work area.

c. Area 9

(1) West Access

Of the four areas, area 9 is the most accessible. Access for the west portion of area 9 would come from State Highway 390, from which, the contractors would follow an existing dirt road to the Right Bank Federal Levee.

(2) East Access

Access to the east portion of area 9 would be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, the contractor could select an access point to the specific work areas.

d. Area 10

(1) West Access

Most of the work in area 10 lies to the west of the river and would be accessed via the Right Bank Federal Levee. From the levee, construction equipment would traverse across existing gravel bars and through brush to the specific work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee would be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

(2) East Access

The work on the east portion of area 10 would be reached from the downstream direction or the upstream direction. From the downstream direction, equipment would travel from State Highway 22 and up the Left Bank Federal Levee for approximately 3 miles to the work areas. From the upstream direction, equipment would travel from Cattleman's Bridge, which is approximately 2 miles away, to Hanson Levee. The spur dikes located to the north would be accessed from Spring Gulch Road, which is about 2 miles away.

Stockpiling of Materials and Staging Areas

Some excavated materials will be temporarily stockpiled on the work sites during the sorting operation. All materials stockpiled onsite would be removed by the end of the current work window. The contractor will be responsible for off-site stockpiling of excavated materials. Excavated material would be stockpiled off-site at a permitted processing facility.

Equipment staging areas will have to meet State and Federal standards for hazardous waste spill containment. Equipment may be staged on-site or off-site depending on environmental conditions. No equipment can be parked on-site past the end of the current work window. The Corps in conjunction with Teton County Natural Resource District personnel would work to locate and setup equipment staging areas whether on or off-site. Any damage or noxious weed infestations caused by equipment use will be mitigated by appropriate restoration or weed control techniques.

Basic Construction Schedule

It is anticipated that one area would be developed per work season. There would be up to two years between construction of structures in one area and the work in the next area of priority. Work is expected to progress over four to eight years.

Yearly Maintenance of Structures

Once work is completed at each area, yearly maintenance will be needed to maintain the integrity of the structures. Maintenance responsibilities have yet to be determined between the Corps and the sponsor. Maintenance will be variable depending on the river/debris flows in any particular year. Maintenance could be performed on any structure which is constructed as part of this project. The maintenance may be as little as replacing a few pieces of fabric and tightening cables

on a brush fence. The maintenance may require total reconstruction of the structure. Sediment traps will also have to be cleaned out periodically. Spur dikes, rock grade control, and channel excavations are the only work described that are expected to need little or no maintenance. The maintenance performed on the other structures will have to be scheduled on a yearly basis. Depending on availability of funds and the level of damage, maintenance work would target those structures that are providing the highest benefit for protection/enhancement. At a minimum, those structures which are damaged and creating a safety hazard would be of highest priority for repair or removal. A biologist would also be needed to monitor and direct certain maintenance activities to insure the activity is not degrading existing habitat or disturbing wildlife species which may also be present.

Listed Species and Effects

The following species list was obtained from the U.S. Fish and Wildlife letter dated June 18, 1998. The discussion is based on the above letter, personnel observations during a site tour on July 7 and 8, 1998, and personal communications with Pat Deibert (USFWS), Rik Gay (Teton County Conservation District), Rob Gipson, and John Keifling, fish biologists (Wyoming Fish and Game Department), Dave Moody, wildlife biologist (WGFD) and the wildlife biologists at the Jackson Office WGFD. The following references were also used:

Corps of Engineers, Walla Walla District, 1994, "Jackson Hole Flood Protection: Levee Access Improvements, Draft Environmental Assessment."

Corps of Engineers, Walla Walla District (1992) Draft "Bald Eagle Management Plan, Jackson Hole Project, Wyoming."

Corps of Engineers, Walla Walla District, 1990, "Jackson Hole, Wyoming, Flood Protection Project: Final O&M Decision Document and EIS."

Federal Threatened and Endangered Species Listing for Area

1. Grizzly Bear (Ursus arctos horibilis)
2. Gray Wolf (Canus lupus)
3. Whooping Crane (Grus americana)
4. Bald Eagle (Haliaeetus leucocephalis)
5. Peregrine Falcon (Falco peregrinus)

Discussion of Alternatives

No Action

If the described work is not performed, the riverine corridor will continue to degrade. The presence of the levee system has already degraded the habitat value of the river corridor and associated wetlands. Not only has the river corridor between the levees degraded, the wetlands that used to be associated with river flooding dynamics have been isolated. This isolation has caused a reversion to upland forest types and meadow grasses. For endangered species, several direct impacts have been realized. The loss of mature riparian forest has reduced the nesting and roosting habitat for bald eagles. The loss of wetlands has resulted in the loss of habitat that may have been used by whooping cranes during migration.

Proposed Alternative

The restoration work presented here is an ambitious undertaking for restoration projects of this kind. The work being proposed will not solve all of the ecological problems caused by the levees. The proposed work will be addressing only restoration work within the riverine corridor. If the proposed work is successful in reestablishing riparian vegetation at the chosen locales, bald eagle habitat will definitely be improved. The other listed species will only gain marginal benefits if any. The proposed work, if successful, will provide a spring board for future projects of this type in the region. Some of this future work will address the restoration of wetlands which will improve the potential habitat for migrating whooping cranes.

The restoration work has been divided into four alternatives based on construction materials used. All alternatives will have maintenance performed to keep them in place for the 50 year life of this project. Some alternatives may require more maintenance than others. Since there are no previous examples of this work to compare to, it is difficult to discuss the outcome of one alternative over another. The work as discussed above will be performed as stated. The maintenance could involve all work areas no matter which alternative is chosen. The discussion below will address the work and the maintenance as a part of the proposed alternative no matter which materials are used.

Discussion of Work and Impacts to Species Listed Above

Basic Work Constraints

The engineering document and discussion on site made it clear that most work will only be accomplished during low flows. The reason for this is that the access to the work areas in the river with heavy equipment will only be possible when flows are low enough to cross side channels when they have little or no water flowing in them. Another reason is the depth of the excavations will be dependent on the level of the river at low flow. All of the excavations except for the sediment traps, spur dikes and

channel excavations will occur in areas which are dry or almost dry. Work on sediment traps, spur dikes and channel excavations can only occur when river levels are at their lowest, to facilitate the construction of temporary water diversions, to minimize the amount of silts being released into the stream.

River flows in this region will peak late spring and early summer depending on temperatures, and snow pack depth. Flows can change quickly during the summer with thunderstorm activity in the region. Thunderstorm activity generally lessens in late August when daytime high temperatures are lower. Mountain snow fields cease to melt at this point. This pattern usually causes river levels to drop by mid-summer. Generally, low flows can occur as early as late August, but depending on weather conditions, can occur as late as mid-October. The first significant snows usually start about mid-October. Snow depths can vary from this point on into winter depending on storm intensity. Work will be difficult in deep snow and will probably have to stop by Thanksgiving. For these reasons most work will be restricted to late summer and fall.

Existing tree and shrub removal will be kept to a minimum and avoided where ever possible. Most of the work in the trees is in conjunction with channel enhancement, pond excavation, brush fence construction, and placement of logs. Access into the sites will use existing channels where only downed trees and other flotsam will be removed. Although some trees and brush are likely to be damaged or removed by the work activity it is not recommended to try and replant these trees and shrubs. The work being performed in these areas is done to open channels, the disturbed areas should quickly revegetate naturally. Another reason for not planting is survival during the first year will be very low. The work itself is supposed to augment natural regeneration of the islands and bars in the work areas. The areas which already have vegetation will have sources for natural propagation through seeds or vegetative means. The equipment being used will take what ever precautions necessary to insure they are not picking up noxious weeds and spreading them to the work areas. Monitoring of work areas will be needed the first year after construction to insure noxious weeds are not present. These weeds will need to be eradicated if found.

Maintenance work would also have to follow this approximate schedule if heavy equipment were needed. Other repair could be accomplished when the structures were exposed at lower river flows. Work on brush fences may be accomplished at any time the fence is accessible by foot or ATV.

Threatened and Endangered Species

Grizzly Bear

The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area. Current management in Wyoming (WGFD) is to discourage grizzly bears from living in areas of human habitation. The last siting of grizzly bears in the Jackson area was in 1994. An adult female with 3 cubs of the year were captured near the Ford property and relocated to an area north of Jackson Hole. The female was attracted to the area because 15 cows, which were killed by lightning, were buried on a site near the Ford property. The biggest concern with this species is attracting them to the Jackson area. The chances a bear will be seen on site would be very rare but precautions are needed since late summer/fall is the time of highest bear activity as they search for food, in preparation for hibernation. Workers should be directed not to leave food and other garbage on site that may attract bears to the area. Some of these stipulations could include keeping the work site free of food and garbage, and storing trash and food in approved containers. If a grizzly bear is seen during work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Since there is only a slight chance of human-grizzly bear encounters the proposed work is unlikely to have an impact on the grizzly bear population.

The grizzly bear will not see direct benefits from the work since the Jackson Hole area has a relatively high human population. Whether the work is successful or not, grizzlies which enter and stay in the area will continue to be relocated. The fisheries benefits will improve the overall health of the river system, which may help the bears indirectly.

The long term maintenance of these structures should not have any impact on the grizzly bear. With the management status and nature of the grizzly bear, the added human disturbance is unlikely to directly impact the bear. Maintenance work would have to follow the same stipulations for the project work regarding food and garbage. If a grizzly bear is seen during maintenance work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

Gray Wolf

Gray wolves are not habitat dependent. They might move through the area in search of food, but the chances of this occurring is very rare. No confirmed sightings have been documented in the area around Jackson. The nearest sightings were recorded in the upper Green River drainage east of Jackson. For these reasons it is unlikely the project will have any impacts on local wolf populations. If a gray wolf is

seen during work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

The gray wolf is considered an experimental population. Like the grizzly bear, management provisions have been made to address conflicts with humans or human activities such as ranching. The Jackson Hole area would be an area where human-wolf encounters would be discouraged. The wolves would use the riverine corridor to travel through the area. Whether the work is successful or not, gray wolves which enter and stay in the area will be relocated. With the limited amount of restoration, the project is unlikely to provide any additional benefits for the wolf population as a whole.

The long term maintenance of these structures should not have any impact on the gray wolf. With the management status and nature of the wolf, the added human disturbance is unlikely to directly impact the wolf. The wolves may learn to avoid the area due to the human activity. If a gray wolf is seen during maintenance work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

Bald Eagle

The bald eagle is the only avian species listed which has nesting habitat in the work area. Bald eagles are known to nest in areas 4, 9 and 10. They also nest in the vicinity of area 1. Nesting usually occurs from February through August.

In area 1 a bald eagle nest has been mapped, in the past, toward the north end of the trees on the east side of the channel. No active nests have been located in this area this year.

Bald eagles are nesting near area 4. Two active nests are located on the east side of the river. One nest is located about 2 1/2 to 3 miles south of the Wilson Bridge, 50 yards outside the levee. The second nest is about 1 1/2 miles south of the first nest, three to four hundred yards outside of the levee. Both nests are on the Ford property.

Bald eagles are nesting near area 9. The nest is located on the west side of the river, outside of the levee, near human habitation.

Bald eagles are nesting near area 10. The nest is in a grove of trees on the north side of the Gross Venture river near the mouth. Both eagles were spotted during our tour.

The letter received from the U.S. Fish and Wildlife Service stated that "no work activity within one mile of any active nests would occur between February 1 and August 15th." For this reason, work will only be allowed within one mile of active nests (current year) from August 16th to January 31st. Changes to this work window must have prior approval from the U.S. Fish and Wildlife Service. No other constraints have been applied to nesting bald eagles. Since it is still unknown when work will actually commence, the project area will have to be surveyed for bald eagle nests, each spring of the year when work is to be performed.

Due to the equipment access restrictions stated under work constraints, construction and excavation activities should not conflict with nesting. All standing mature trees in the work area will be avoided if at all possible. Trees which are leaning or already on the ground may be moved aside to facilitate excavation and construction. All of the known eagle nesting trees are currently located outside of the levee system. The biologist onsite will work with the contractor to avoid areas where equipment could damage mature trees.

Bald eagles will also be wintering in the area as long as there is a food source. The biologist on site would monitor for the presence of eagles and provide guidance to the work crews to avoid activities which might disturb the eagles. It is not anticipated that the work activity will cause additional disturbance to the eagles, using the area, beyond the human disturbance already occurring through normal recreational use.

Bald eagles are likely to be found in or near the work area most of the year. The chances of the project having any impact on the bald eagle are minimal due to the timing of the active work. There will likely be no direct impacts (mortality, loss of nest, etc.) or long-term population impacts (reduced reproduction, etc.). There may be some minor displacement to foraging or roosting eagles. For these reasons the project work *May Affect But Is Not Likely To Adversely Affect* bald eagles using the area.

If the project is successful and riparian vegetation can reestablish, bald eagle nesting and roosting habitat will improve. These benefits will not be realized for 30 to 50 years when new cottonwood trees reach maturity. This will be offset somewhat by the continuing maintenance activities which will occur on a yearly basis. The main impact will be the added human activity. The timing/buffer zone of the maintenance work will be similar to the project work. This should alleviate impacts to the nesting population. The added human activity may cause eagles to avoid the area for foraging during ongoing maintenance activities. The biologist on site would monitor for the presence of eagles and provide guidance to the contractor to avoid activities which might disturb the eagles. For this reason the maintenance work will likely have no direct impacts (mortality, loss of nest, etc.) or long-term population impacts (reduced reproduction, etc.). There may be some minor displacement to foraging or roosting

eagles. For these reasons the maintenance work *May Affect But Is Not Likely To Adversely Affect* bald eagles using the area.

Whooping Crane

Whooping cranes do migrate through the area of Jackson Lake during early spring. The birds are migrating through the area to Gray's Lake and will stop briefly at Jackson Lake. There is a chance a whooping crane may stop along the river in the Jackson area, especially if sandhill cranes are using the area. The chances of a whooping crane stopping in the work area would be extremely rare. The cranes would be attracted to wetland pastures and not the riverine corridor between the levees. The confluences of Blue Crane and Fish Creeks are the only two areas which might attract cranes. Most of the work will be taking place between August 15th and November 15th because of concerns with bald eagle nesting and big game migration. For these reasons the project will have no impacts on the whooping crane population.

There is a small chance that a whooping crane could land and feed in the riverine corridor in spring. If a whooping crane is seen during work activities, *work will cease.* Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Work will resume only after USFWS personnel have been consulted on how to proceed.

If the project is successful the whooping crane habitat will not benefit from the vegetation growth derived from this work. If the work leads to future restoration in the area, then wetland habitats outside of the levee may improve which will benefit whooping cranes. The ongoing maintenance work will be occurring at the same time as the project work (summer-fall). For this reason the maintenance work should have no impact on the whooping crane population.

If a whooping crane is seen during maintenance activities, *work will cease.* Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Work will resume only after USFWS personnel have been consulted on how to proceed.

Peregrine Falcon

Peregrine falcons are residents and migratory to the area. Two known eyries are located in the vicinity of the Grand Tetons. Peregrines do use the river corridor for foraging. Currently, one peregrine forages in the South Park area near Fish Creek. This area is near the west side of area 4. Peregrines will leave the region soon after nesting is complete. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August. The biologist on site

would monitor for the presence of falcons and provide guidance to the contractor to avoid activities which might disturb the falcons.

Since the bulk of the project work will occur after nesting season, the chance of the project impacting the foraging of peregrines would be minimal. For this reason the project work *May Affect But Is Not Likely To Adversely Affect* peregrine falcons using the area.

If the project is successful, the peregrine falcon will not realize any direct benefits. The falcon could see indirect benefits if passerine bird populations increase as a result of the new vegetation growth. This will be offset somewhat by the yearly maintenance activity needed to maintain the protective value of the construction work. Since most of the maintenance work will occur after nesting season, the chance of the maintenance work impacting the foraging of peregrines would be minimal. For this reason the maintenance work *May Affect But Is Not Likely To Adversely Affect* peregrine falcons using the area.

Conclusion

Based on the above lack of anticipated negative impacts, it is determined that the above described actions *"May Affect But Is Not Likely To Adversely Affect"* bald eagles and peregrine falcons use of the area or their habitats. The described action will have no effect on gray wolves, grizzly bears, and whooping cranes use of the area or their habitats.

If you have any questions or desire additional information about the proposed action, please contact Mr. Scott Ackerman at 509-527-7272.

Sincerely,

Peter F. Poolman
Chief, Environmental Compliance Branch

ACKERMAN/PD-EC/ss

~~SMITH~~/OD-RF SA

~~MACDONALD/PM~~

CANNON/PD

POOLMAN/PD-EC

PD-EC FILES

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CENWW-OD-RF (Smith)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morris Avenue
Cheyenne, Wyoming 82001

ES-61411.
pd/WY1782/tcnrdwallacoe.pd

June 18, 1998

Mr. Carl Christianson
U.S. Army Corps of Engineers
Walla Walla District
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Christianson:

Thank you for your letter of May 21, 1998, for the Snake River riparian and restoration project in Teton County, Wyoming.

In accordance with section 7(c) of the Endangered Species Act of 1973, as amended (Act), my staff has determined that the following threatened or endangered species may be present in all project areas.

Species	Status	Expected Occurrence
Bald eagle (*Haliaeetus leucocephalus*)	Threatened	Nesting. Winter resident. Migrant.
Peregrine falcon (*Falco peregrinus*)	Endangered	Nesting. Migrant.
Whooping crane (*Grus americana*)	Endangered	Resident. Migrant.
Gray wolf (*Canis lupus*)	Experimental (Formerly Endangered)	Potential resident.
Grizzly bear (*Ursus arctos horribilis*)	Threatened	Resident.

There are bald eagle nests located in project areas 1 and 10. Therefore, all activities associated with areas 1 and 10 should not occur until after August 15 and be completed by February 01 to prevent disturbance to these nests. Bald eagle nests are also adjacent project areas 4 and 9. All activities associated with these areas that are within one mile of an active bald eagle nest must also be restricted to the time period specified above. If it is determined that the proposed

We are planning a site visit and complete analysis of this project area this upcoming summer. At that time, we may have additional recommendations which we will immediately forward to your office. If you have any questions please contact Pat Deibert of my staff at the letterhead address or phone (307) 772-2374.

Sincerely,

Mary E Jennings
for Michael M. Long
Field Supervisor
Wyoming Field Office

cc: Director, WGFD, Cheyenne, WY
Nongame Coordinator, WGFD, Lander, WY

APPENDIX B

COORDINATION ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

ES-61411
pd/W.06/snakecar.pd

October 27, 1998

Mr. Carl J. Christianson
Chief, Environmental Planning Branch
Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Christianson:

We have reviewed the Corps' comments on the final Coordination Act Report for the Snake River Environmental Restoration Project, and modified the report based on those comments. Enclosed is the revised final Fish and Wildlife Coordination Act Report for the proposed project. The report was completed pursuant to the scope of work dated April 17, 1998, and prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S. C. 661 et seq.).

We look forward to continuing our work with the U.S. Army Corps of Engineers on this project. If you have any questions on this report please contact Pat Deibert of my staff at (307) 772-2374, ext. 26.

Sincerely,

Michael M. Long

Michael M. Long
Field Supervisor
Wyoming Field Office

COORDINATION ACT REPORT
Snake River Restoration Project

The U.S. Fish and Wildlife Service has reviewed the proposed Snake River Environmental Restoration Project, a proposal to provide ecosystem restoration to four areas on the Snake River between Moose and the South Park Feed Grounds near Jackson Hole, Wyoming. This report has been prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S. C. 661 et seq.).

Project Description:

The Snake River in the Jackson area is confined by levees constructed and maintained by the Snake River Flood Control Project (U.S. Fish and Wildlife Service 1990). Concentration of the river flows by the levees has caused extensive erosion, resulting in loss of aquatic and terrestrial wildlife habitat. Fish and wildlife impacts resulting from construction, operation and maintenance of the Flood Control Project have significantly changed the character of the Snake River ecosystem (U.S. Fish and Wildlife Service 1990). The goal of this restoration project is to provide environmental and wildlife habitat restoration of riverine, wetland and riparian habitats within four selected study areas. To accomplish this goal, stability of the channel will be increased and frequency of island removal/destruction will be decreased to allow maturation of vegetation on forested islands and re-vegetation of denuded islands. This project is proposed by the U.S. Army Corps of Engineers, with cooperation of the Teton County Natural Resource District.

Four areas have been selected for restoration. Area 1 is located in sections 13, 14, 23 and 24 of Township 40N, Range 117W; Area 4 is located in sections 2, 3, 10 and 11, Township 40N, Range 117W; Area 9 is located in sections 13 and 24, Township 41N, Range 117 W; and Area 10 is located in sections 5,6 and 7, Township 41N, Range 117W (Figure 1). All sites are in Teton County, Wyoming.

Area Description:

The vegetation in the four project areas is characterized by shrub willow (*Salix* ssp.)/cottonwood (*Populus* ssp.) riparian communities supported by the natural hydrology of the river system. Other species common within the floodplain and on islands include Englemann spruce (*Picea englemannii*) and blue spruce (*Picea pungens*), silverberry (*Eleagnus commutata*), alder (*Alnus incana*), Wood's rose (*Rosa woodsii*), buffalo berry (*Sherpherdia canadensis*) and honeysuckle (*Lonicera involucrata*) (U.S. Army Corps of Engineers 1994). Installation of levees has reduced the quantity of the riparian habitat within the levees from 2,761 acres in 1956 to 1,176 acres in 1986. The quality of the remaining riparian habitat has also declined (U.S. Fish and Wildlife

Service 1998). The area of cottonwood forest behind the levees has remained approximately constant between 1956 and 1986, but the quality of this habitat has been reduced. The percent of mature cottonwoods has increased behind the levees, indicating that cottonwood regeneration has declined. There has also been a 149 percent increase of cottonwood-spruce habitat from 1956 to 1986 behind the levee indicating a loss of riparian habitat. The loss has been compounded by the side channels and spring creek habitats being cut-off from the river by the levees (U.S. Fish and Wildlife Service 1998).

Area 1 is the only area not bounded by levees along both banks. Within the past few years the west bank has undergone extensive lateral erosion due to the "firehose"effect of concentrated river flows emerging from the confined channel upstream. Greater than 300 acres of pastureland have been lost from this erosion. Vegetation in this area is a combination of shrub willows/cottonwoods on the shore line with some cottonwoods on an existing island. However, these cottonwoods are in danger of removal from high river flows. Surrounding land use is ranching and rural residential.

The vegetation around Area 4 is predominantly shrub willow. Most of the existing islands currently within the channel are void of vegetation due to island instability and changing river flows. This area is bordered by a developing subdivision on the west side. The Jackson Land Trust has obtained an easement on many of the lots within this subdivision for the protection of trumpeter swan wintering and feeding habitats (D. Stevenson, WGFD, pers. comm.). The surrounding land use is rural residential.

Area 9 is bounded by Highway 22 to the south and contains a boat ramp on the west bank used extensively by recreational boaters and outfitters. Vegetation in this area is predominantly shrub/willow, with some mature cottonwoods on an existing island. Surrounding land use is light business, transportation and rural residential. A portion of this area has been selected as a demonstration area to test the proposed restoration techniques. Restoration efforts, to be implemented by Teton County Natural Resource District, are scheduled to begin in the Fall of 1998.

Area 10 is located at the confluence of the Gros Ventre and Snake Rivers. This area has extensive cottonwood vegetation on existing islands and along the shoreline. However, some of the island vegetation was removed by high spring flows in 1998. Surrounding land use is rural residential.

Restoration Techniques:

Several methods are proposed to accomplish the proposed restoration including gravel removal, anchored root wads, brush fences, spur dikes and rock grade control. Table 1 outlines the techniques proposed for use by area. According to personal communications with Teton County Natural Resources District and U.S. Army Corps of Engineers personnel, all construction is

proposed to occur during low water flows in September through early November. Annual maintenance of restoration features may be necessary to maintain their protection/enhancement capabilities.

TABLE 1: Restoration treatments proposed by project area.

TREATMENTS

	Gravel Removal			*Fences*	*Dikes*	*Root Wads*	*Rock Grade*
	Channel Capacity	Side Pools	Sediment Traps				
Area 1		X	X	X		X	
Area 4	X	X	X	X	X	X	
Area 9	X	X		X	X	X	X
Area 10	X	X	X	X	X	X	

Gravel Removal
Confinement of the Snake River within levees has resulted in areas of unusually high gravel deposition and reduced channel capacity. Removal of excess gravel from these areas will improve fish habitat (by creating resting areas in side pools), maintain channel capacity, increase channel stability and improve sediment transport. Removal would be accomplished with excavators, loaders, dump trucks and grizzlies. The Wyoming Department of Environmental Quality has not yet made the determination on whether or not construction equipment can be operated in flowing water. If construction equipment is not permitted to operate in flowing water temporary diversion dikes will be necessary. Material for these dikes would be from existing riverbed material (U.S. Army Corps of Engineers 1998). Gravel removal in should not occur in side channels to prevent fish entrapment during low water levels.

Brush Fences
Brush fences will be used to help re-establish island riparian habitat and to protect existing island habitat by slowing water velocities and reducing the energy of water flows. Rock grade control structures would be used in conjunction with brush fences in Area 9 to prevent channel down-cutting. Brush fences may be constructed using piling with lateral cables, or with riprap (rock brush fences). Piling brush fences would be constructed by excavating along the fence alignment and driving piles into the river bottom with vibratory hammer mounted on a backhoe. Rock

brush fences will be constructed by excavating a trench to a depth of 4 feet. The trench site would be filled with riprap material of sufficient size to resist removal from high flows. Small materials from the excavation would be hauled off-site (U.S. Army Corps of Engineers 1998).

Spur Dikes

Spur dikes will be used for fisheries habitat enhancement and bank protection. These dikes will create flow diversity and enhance pools, fish resting areas, riffles and seams (U.S. Army Corps of Engineers 1998). Two kinds of spur dikes may be used: kicker dikes and bank barbs. Kicker dikes will be composed of riprap armor with a random fill core and will extend 56 feet into the river. Bank barbs will consist only of riprap and extend 26 feet into the river. Riprap material will be hauled to the dike location with dump trucks (U.S. Army Corps of Engineers 1998).

Anchored Root Wads

Root wad logs would be anchored into the river bottom to protect existing islands and to encourage growth of new islands. On-site root wad logs will be the primary source of this material. If a secondary source is required, this source will be designated by a Corps representative. Installation of the root wads may require leveling of the area by a backhoe. Logs will be fastened with toggle bolt anchors driven in to the ground with a jackhammer (U.S. Army Corps of Engineers 1998). Root wads will not be placed in the lower reaches of Blue Crane or Spring Creek to ensure these areas remain accessible as spawning tributaries.

Rock Grade Control

A rock grade control structure will be used to keep the river from eroding through existing riparian habitat. The rock grade control structure will consist of riprap and will be flush with the existing channel bottom. The footprint of the structure would be excavated and material hauled off-site. Riprap would be placed in the excavation area by carefully keying riprap together (U.S. Army Corps of Engineers 1998).

Access

Access to the western side of Area 1 would be via the existing Fall Creek Road and associated dirt roads. Access would also be provided on levee roads. However, the exact location for river access by heavy equipment, etc. has not been determined at this time. Access to the east side of Area 1 would be along existing roads to levees until the levee terminates. After the levee ends, access would continue through existing shrubs and trees over gravel bars. The exact route taken will be determined by the Corps and will be selected to minimize disturbance to the riparian community.

Access to the western side of Area 4 would be from the existing Fall Creek Road and an associated gravel road. At the road termination, the operator will need to navigate across gravel bars along the channel bottom. Access to the eastern side of this area will be from the Federal Levee Extension. This proposed access is still under negotiation with the adjacent landowner and may change.

Western access to Area 9 would be via State Highway 390 to an existing dirt road and along the right Bank Federal Levee. Eastern access to this area will be from State Highway 22 to the Left Bank Federal Levee. From this levee, the contractor will select access points for specific work areas.

Access to the western side of Area 10 would be via the Right Bank Federal Levee. From the levee, construction equipment will traverse across existing gravel bars and through brush to specific work areas. Eastern access to this area will be via State Highway 22 to the Left Bank Federal Levee or from Cattleman's bridge to the Hanson Levee. The spur dikes located to the north will be accessed from Spring Gulch Road.

Alternatives

Five alternatives are proposed - no action, and four structural alternatives designed to withstand differing intensities of flood events. The structural alternatives include designs to withstand a 15-year flood event, a 25-year flood event and two designs to handle a 50-year flood. Potential impacts of these alternatives are discussed in the following Project Impacts sections. The final preferred alternative will be selected based on incremental benefit analysis.

Fish and Wildlife Resources - Existing Condition

Aquatic Resources

Within the four project areas, the Snake River is designated as a Class 1 trout fishery as designated by the Wyoming Game and Fish Department. This designation signifies the River is of national importance as a trout fishery. This fishery is composed primarily of Snake River cutthroat trout (*Oncorhynchus clarki* ssp.). Other game fish present include mountain whitefish (*Prosopium williamsoni*), brown (*Salmo trutta*), brook (*Salvelinus fontinalis*), rainbow (*Oncorhynchus mykiss*) and lake trout (*Salvelinus namaycush*). Non-game fish include the Bonneville redside shiner (*Richardsonius balteatus*), speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), Utah chub (*Gila atraria*), leatherside chub (*Gila copei*), Utah sucker (*Catostomus ardens*), bluehead sucker (*Catostomus discobolus*), mountain sucker (*Catostomus platyrhynchus*), mottled sculpin (*Cottus bairdi*) and Paiute sculpin (*Cottus beldingi*) (U.S. Fish and Wildlife Service 1990).

Spawning habitat for the Snake River cutthroat trout is considered one of the major factors limiting population for this species in the upper Snake River drainage. Spawning is limited to spring-fed tributaries. Little or no spawning habitat exists in the main river because high flows, particularly during spring run-off, produce large sediment bed loads and turbidity during the

spawning period. Habitat losses of spawning habitat have occurred from human activities. including diversions for irrigation and levee construction (U.S. Fish and Wildlife Service 1990). Mountain whitefish are very abundant within the project area and prefer fast. deep water. They are also commonly found in riffle areas in the summer. The Snake River and its tributaries are major spawning areas for this species (U.S. Fish and Wildlife Service 1990). Spawning occurs in September and can continue through November. Non-game fish in this system provide important forage for game fish and fish-eating raptors in the area.

Terrestrial Resources - Avian

Over 150 different species of birds have been observed along the Snake River corridor. Of those, 119 are documented breeders. Seventy-nine percent of the area's breeding birds are associated with the cottonwood-riparian and wetland habitat types found along the Snake River. Many species also congregate and use the area for feeding and resting during spring-fall migration (U.S. Fish and Wildlife Service 1990).

Of the total number of bird species identified, approximately 75 percent are passerines (Table 2). Nearly 65 percent of those birds are probable or documented breeders in this area indicating the value of the riparian habitat to this group. No threatened or endangered passerines, or passerines classified as State species of special management concern occur in any of the project areas (Wyoming Game and Fish 1996, 1997).

All raptors documented within the area breed there (Table 3). Two species, the osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) obtain their primary food (fish) from the Snake River. Ospreys are very common in the Jackson area. The Snake River and tributaries provide large amounts of foraging habitat for this raptor because of abundant fish populations (U.S. Fish and Wildlife Service 1990).

Active bald eagle nests occur in close proximity of all four project areas. This species is currently listed as threatened by the U.S. Fish and Wildlife Service, and as a Native Species Status 2 by the Wyoming Game and Fish Department due to on-going significant habitat loss within the State. The bald eagle nest at Area 1 is approximately 300 to 400 yards inland from the eastern river bank (and proposed restoration work). This pair is inconsistently successful in producing fledgings from this nest (D. Stevenson, WGFD, pers. comm.) At Area 4, the bald eagle nest is approximately 50 yards from the eastern levee (and the proposed restoration work). This nest has been consistently productive. The nest at Area 9 is just north of the project area in section 13 and is in close proximity of a restaurant and other high disturbance areas. This nest has been consistently successful despite the disturbance. The nest at Area 10 is along the Gros Ventre River just upstream from its confluence with the Snake River. This pair often relocates their nest annually, but typically uses locations on the Snake and Gros Ventre Rivers within the

proposed restoration area (D. Stevenson, WGFD, pers. comm.). The bald eagle population in the Greater Yellowstone Ecosystem is considered one of the most important breeding populations in the Rocky Mountains and has been increasing since the 1970's. The Snake River unit of this population contributes significantly to current recovery trends of the bald eagle in this region (U.S. Army Corps of Engineers 1994). Both bald eagles and osprey commonly use snags and large living trees for nesting and roosting. Declines of this habitat component are occurring due to hydrologic changes as a result of levee construction (U.S. Army Corps of Engineers 1994).

Two peregrine falcon (*Falco peregrinus*) aeries occur within 15 miles of the proposed restoration areas. Although the restoration project will have no direct impact on these aeries, the adults from these nests often forage within the project areas, particularly Areas 1 and 4 (D. Stevenson, pers. comm.). This species is currently classified as endangered by the U.S. Fish and Wildlife Service, and as a Native Species Status 3 species by the State of Wyoming due to restricted habitat availability and declining populations (Wyoming Game and Fish Department 1996).

Resident and migratory waterfowl use the Snake River and its tributaries for spring/fall staging, breeding, nesting, brood rearing and wintering habitat (Table 4). Trumpeter swans (*Cygnus buccinator*) winter on the Snake River near all four project areas. Winter is a critical time for this species due to decreased availability of habitat and increased competition with other waterfowl species for food (U.S. Army Corps of Engineers 1994). Fish Creek, which flows along the western side of the Snake River near Areas 1 and 4 provides important feeding and wintering habitat for this species. Swans also use the Gros Ventre River at its confluence with the Snake River (Area 10) for feeding and wintering (D. Stevenson, WGFD, pers. comm). However, this species does not nest along the Snake River. The trumpeter swan is classified as Native Species Status 2 by the Wyoming Game and Fish Department, indicating special management efforts are warranted due to on-going significant loss of habitat (Wyoming Game and Fish Department 1996). Other common waterfowl species in this area include the Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), American wigeon (*Anas americana*), green-winged (*Anas crecca*) and blue-winged teal (*Anas discors*), common goldeneye (*Bucephala clangula*), Barrow's goldeneye (*Bucephala islandica*) and ring-necked duck (*Aythya collaris*).

Common loons (*Gavia immer*) use the Snake River, including the project areas, as a resting stop during the spring migration. This species is classified as Native Species Status 1 by the State of Wyoming in recognition of declining populations and on-going significant habitat loss (Wyoming Game and Fish Department 1996). American white pelicans (*Pelecanus erythrorhynchos*) also use the Snake River in and near the project areas, particularly Areas 1 and 4, for foraging. These birds typically leave the river by late summer (D. Stevenson, WGFD, pers. comm.).

A great blue heron (*Ardea herodias*) rookery is approximately 400 yards from the east bank of the Snake River at Area 1. This species is common in the Jackson area. Most migrate out of the

area in late fall, but there are a few resident birds (U.S. Army Corps of Engineers 1994). The endangered whooping crane (*Grus americana*) occasionally migrates through the project area enroute to Jackson Lake and Grand Teton National Park to the north. However, this species is not common in the project area. Sandhill cranes (*Grus canadensis*) are widely distributed in the Jackson area and occur primarily in association with wetlands and agricultural fields. This species migrates out of this area by late September (U.S. Army Corps of Engineers 1994).

Terrestrial Resources - Mammals

Four species of big game animals are common along the Snake River corridor near the proposed restoration areas. Areas 1 and 4 provide crucial winter-yearlong range for moose (*Alces alces*) in the Sublette herd management unit and Areas 9 and 10 provide crucial winter-yearlong range for moose in the Jackson herd management unit. Crucial range is defined by the Wyoming Game and Fish Department as habitat necessary to ensure the long-term survival of a population of animals at a desired level. In addition to the above designation, Area 9 is within a migration corridor for moose within the Sublette herd unit. Elk (*Cervus elaphus*) from the Fall Creek herd management unit winter along Areas 1 and 4, but this habitat is not considered crucial. Elk from the Jackson herd management unit migrate through Areas 9 and 10 (J. Bohne, WGFD, pers. comm.).

All four areas provide spring/summer/fall habitat for mule deer (*Odocoileus hemionus*). Areas 1 and 4 provide habitat for deer within the Sublette herd management unit while Areas 9 and 10 provide habitat for deer within the Jackson herd management unit. The east side of Area 10 is designated as crucial winter range for mule deer in the Jackson herd management unit (J. Bohne, WGFD, pers. comm.).

The grizzly bear (*Ursus arctos*) is a resident species to the area, primarily north of the Jackson Hole area. This species is listed as threatened by the U.S. Fish and Wildlife Service. Current management by the Wyoming Game and Fish Department is to discourage grizzly bears from living in areas of human habitation. The last sighting of a grizzly bear in the Jackson area was of a sow and 3 cubs of the year in 1994 near Area 4. The bears were attracted to the area by 15 cows killed by lightening. The bears were captured and successfully relocated to an area north of Jackson.

In 1995, gray wolves (*Canis lupus*) were re-introduced into Yellowstone National Park and the Greater Yellowstone ecosystem. Some wolves have dispersed to areas outside the Park. However, no confirmed sightings have been documented around Jackson, or in the project area. Gray wolves are not habitat dependent, but could potentially move through the area in search of food. All wolves within Wyoming are now considered part of a nonessential experimental population. Although such wolves remain listed and protected under the Endangered Species

Act (Act), additional flexibility is provided for their management under the provisions of the final rule and special regulations promulgated for the nonessential experimental population on November 22, 1994 (59 FR 60252). On any unit of National Park System or National Wildlife Refuge System lands, wolves that are part of the experimental population are considered a threatened species and the full provisions of section 7 of the Act apply. Additional management flexibility is provided for managing wolves existing outside units of the National Park or National Wildlife Refuge System. Wolves designated as nonessential experimental in these areas are treated as proposed rather than listed.

Common furbearers in the project area include the mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*) and beaver (*Castor canadensis*). Mink are found in relatively lower densities and prefer riverbottom habitats that provide adequate cover and an abundant food source. Selected prey items include fish, amphibians, birds and various small mammals, fruits and berries. The presence of riprap flood protection levees has created an abundance of denning habitat for this species (U.S. Army Corps of Engineers 1994). Muskrats are a common resident of ponds, oxbows and spring creeks within the project area. They feed primarily on aquatic vegetation. Muskrats are economically important as a furbearer and are annually harvested within and adjacent o the project area.

The Snake River is identified as one of the most significant areas in Wyoming for the river otter. Otters use log jams, pools and oxbows as foraging areas due to the large number of fish which congregate in these areas. Due to the lack of suitable habitat, otters are not common between levees (U.S. Army Corps of Engineers 1994). Beavers are also present in the project areas. They rely heavily on cottonwood trees for lodge and dam construction and prefer vegetation in the willow shrub under story as a food source. Flood control levees have decreased the availability of denning habitat for this species (U.S. Army Corps of Engineers 1994). Prime habitat is found along spring creeks, side channels and oxbows.

A number of small mammalian species use the project area on a permanent, seasonal or transient basis. Populations of small mammals are cyclic in nature with densities varying by season. However, if sufficient habitat is available, small mammal densities are relatively high. The multi-layered herbaceous vegetation provides a diverse habitat for various mammal species found in the area. The masked (*Sorex cinereus*), dusky (*Sorex monticolus*) and northern water (*Sorex palustris*) shrews are documented in the project area and prefer mesic habitats with a source of water nearby. The project area provides an abundant terrestrial and aquatic insect source for shrews. Vole species include the southern red-backed (*Clethrionomys gapperi*), heather (*Phenacomys intermedius*), montane (*Microtus montanus*), meadow (*Microtus pennsylvanicus*), water (*Microtus richardsoni*) and long-tailed (*Microtus longicaudus*) voles. Area riparian habitats supply voles with an abundance of plant material, seeds, fruits and insects for food as well as leaf litter, logs and windfallen trees for security. Deer mice (*Peromyscus maniculatus*) and western jumping (*Zapus princeps*) mice are also found in the cottonwood understory. Squirrels found in the project area include the golden mantled ground squirrel

(*Spermophilus lateralis*), yellow-bellied marmot (*Marmota flaviventris*), red squirrel (*Tamiasciurus hudsonicus*), Uinta ground squirrel (*Spermophilus armatus*) and least chipmunk (*Tamias minimus*). Other small mammals common to the area include the northern pocket gopher (*Thomomys talpoides*), bushy-tailed woodrat (*Neotoma cinerea*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*) and porcupine (*Erethizon dorsatum*).

Reptiles and Amphibians

The project areas may provide habitat for the tiger salamander (Ambystoma tigrinum), northern leopard frog (*Rana pipiens*), spotted frog (*Rana pretiosa*), boreal chorus frog (*Pseudacris triseriata maculata*), rubber boa (*Charina bottae*), bullsnake (*Pituophis melanoleucas sayi*), wandering garter snake (*Thamnophis elegans vagrans*) and valley garter snake (*Thamnophis sirtalis fitchi*).

Project Impacts - General

Determining the actual project impacts to terrestrial and aquatic wildlife is difficult given the changing morphology of the Snake River. Engineering plans finalized in the summer of 1998 will likely be changed for some project areas due to the continually changing river structure from high water flows. For example, some islands designated for protection were destroyed by spring flows in 1998, and gravel has been re-distributed in other areas, making changes in the location of gravel removal necessary. Below is a summary of projected impacts to terrestrial and aquatic wildlife. Due to river changes, these descriptions have been kept necessarily general and may be changed if significant engineering changes are necessary for project completion.

Projected Impacts - Aquatic Wildlife

There will be significant disturbance to fishes and aquatic invertebrates due to instream construction activities. The impacts may include direct mortalities, movement disruption and/or temporary habitat displacement. No existing aquatic wildlife resources have been identified as currently being threatened due to limited population size. If the work is completed during the fall, spawning migrations of the Snake River cutthroat trout will not be disrupted. However, spawning activities and redds of mountain whitefish may be disrupted within each project area. These impacts are not expected to significant or long-term (J. Kiefling, WGFD, pers. commun.)

The proposed restoration project was described in the Coordination Act Report drafted for the maintenance of the Snake River levees in 1988 as mitigation for those activities (U.S. Fish and Wildlife Service 1990). If successful, the proposed project will benefit aquatic wildlife, particularly Snake River cutthroat trout, by providing resting areas, channel stability and overhanging vegetation. The proposed project is supported by Wyoming Game and Fish Department. A cutthroat habitat evaluation procedure has been proposed by the Wyoming Game

and Fish Department, with concurrence of the U.S. Army Corps of Engineers, to measure the effectiveness of the implemented restoration measures. This procedure will allow comparison to pre-restoration conditions to assess the effectiveness of the project. In order to adequately assess any impacts or benefits of this project, monitoring will be necessary for a minimum of three years will be. Although this project will assist in restoration of limited areas of fishery habitat, a system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by continued building of levees along the Snake River. A riparian maintenance plan should be developed by an interdisciplinary team to preserve the diversity and value of this ecosystem.

There should not be significant differences in potential impacts to aquatic wildlife between the four action alternatives. However, displacement and temporary habitat disruption will occur more frequently with the 15-year and 25-year alternatives, versus the 50-year alternatives, due to the increased necessity of repair work on the structures with the shorter expected life spans.

There may be a negative impact to fishing-related recreation within the project areas. Low flows in September and October provide excellent flyfishing opportunities in the Snake River. Many commercial outfitters float through the project areas while providing guided flyfishing tours. The proposed construction activity may disrupt some of these activities. All efforts should be made to inform the outfitters of construction schedules, including daily communications, if necessary. Additionally, river diversions should be designed to allow passage of boats at all times. Given the short duration of construction activities, there should be no long-term impacts to recreational fishing.

Project Impacts - Terrestrial Wildlife

To determine the impacts of project construction on wildlife habitat within the four project areas, the Habitat Evaluation Procedures (HEP) were used to evaluate the quality and quantity of two representative vegetative cover types; palustrine shrub scrub and palustrine forest, including cottonwoods. The palustrine shrub scrub cover type was evaluated using a modification of the yellow warbler (*Dendroica petechia*) HEP model. A modification of the song sparrow (*Melospiza melodia*) HEP model was used to evaluate the palustrine forest habitat. Using HEP, habitat quantity and quality are quantified and multiplied together to produce "habitat units." A comparison of habitat units for baseline and "with project" conditions allows HEP users to quantify project impacts/benefits.

Using estimates of habitat type coverage and quality from 1991 and 1996 uncontrolled aerial photos, field data collected in 1996, and estimates of habitat quantity and quality with restoration efforts, changes in habitat units for these two cover types were projected for 50 years after project implementation. These results are based on the expected habitat changes under both 50-year alternatives. An incremental analysis was subsequently conducted on both the 15- and 25-

year alternatives. Changes in habitat units for a "no action" alternative were also estimated. For the palustrine shrub scrub cover type, the number of habitat units for yellow warblers progressively increased over time after implementation of the proposed project for all four areas. Under the no action alternative, the number of habitat units are projected to decline (Table 5). Similarly, for the palustrine forest the number of song sparrow habitat units also increased progressively over time for all four project areas with the 50-year alternatives after project completion (Table 5). The incremental analysis showed that there would be smaller increases in habitat units under the 15- and 25-year alternatives. The no action alternative resulted in a decrease of habitat units (Table 5). These data also suggest that cottonwood re-generation and retention would be stimulated by implementation of the project.

TABLE 5: Summary of HEP results for each Project Area and Habitat Type. Results are presented for data collected in 1996, projected values 50 years after project implementation (50 Years), and no action (NA).

	Area 1			Area 4			Area 9			Area 10		
Shrub/ Scrub	1996	50 Years	NA	1996	50 Years	NA	1996	50 Years	NA	1996	50 Years	NA
Habitat Units	126.6	318.9	76.1	71.7	98.1	43.5	7.6	13.2	4.4	24.9	45.3	15.0
Acres	384.5	398.7	230.7	105.1	122.6	63.1	10.7	16.5	6.4	37.9	56.5	22.7
HSI Values	0.33	0.80	0.33	0.68	0.80	0.69	0.71	0.80	0.69	0.66	0.80	0.66
Forest												
Habitat Units	1.9	10.4	1.1	37.4	53.4	22.5	5.2	8.2	3.1	26.3	47.9	15.0
Acres	2.8	12.0	1.7	44.1	61.4	26.5	6.0	9.4	3.6	31.3	55.1	18.8
HSI Values	0.68	0.87	0.68	0.85	0.87	0.85	0.87	0.87	0.85	0.84	0.87	0.80

The results of the HEP analyses suggest the proposed work will benefit terrestrial wildlife by restoring riparian habitat. Stabilization of existing and re-generation of new riparian vegetation will ultimately result in an increase in density, and possibly diversity, of terrestrial wildlife. There will be short-lived negative impacts from access routes, staging areas for gravel sorting and heavy equipment storage, reduced air and noise quality and increased traffic. Actual impacts from these associated activities cannot be fully assessed at this time since access routes and

staging areas have not been determined for all sites. However, these impacts should be temporary (occurring during the construction period only) and if mitigated, long-term impacts will be minimal, and more than offset by project benefits.

If the fall construction schedule is followed, impacts to nesting birds, such as bald eagles, ospreys and other raptors, great blue herons, waterfowl, shorebirds and passerines will be minimal. Cottonwood regeneration will result in continued nesting and roosting habitat for ospreys, bald eagles and other raptors, as well as great blue herons. These resources would decline without the project. The fall construction schedule will also eliminate impacts to spring migratory birds, including common loons and whooping cranes. Impacts to peregrine falcons should be minimal since young of the year will have fledged and will no longer be completely dependent on adults foraging within project areas 1 and 4. Trumpeter swans typically move into winter feeding areas in late November to early December. Completion of the project by early November will minimize impacts to trumpeter swans wintering in the area. Some displacement of fall migrants, including waterfowl and sandhill cranes, may occur. However, given the limited size of each project area, sufficient staging and feeding habitats outside the disturbance should still be available.

If all work in each project area is completed by early November, impacts to big game species dependent on these areas should be minimal. Elk, mule deer and moose typically begin to use these areas in mid to late November, depending on early season snowfall amounts. There should also be minimal impacts to animals migrating to and from feedgrounds in the area since these migrations often occur in late November and December, and in April and early May (J. Bohne, WGFD, pers. comm.).

The potential for occurrence of grizzly bears and gray wolves in the project areas is minimal and the project should have no impact on these species. However, every precaution should be taken by the construction crews to ensure grizzly bears are not attracted to the work site. There may be indirect impacts (displacement and temporary habitat loss) to furbearers in the area. However, these impacts should be minimal due to the limited size of each project area. Additionally, any impact to this group should be fully mitigated by the improvement in riparian habitat gained through project implementation. There should be no impacts on furbearer trapping activity since seasons for most furbearers begin after construction is proposed for completion.

There will likely be some direct loss of small mammals and their habitat, as well as associated impacts, such as displacement. However, most of the small mammals in the area have a high reproductive capacity, and long-term population impacts are not anticipated. Additionally, habitat for these species should increase after project implementation. Similarly, there will likely be direct and indirect losses to some reptiles and amphibians. However, long-term population impacts are not anticipated.

Recommendations:

1. Use existing access routes and staging areas where possible. If new access routes must be constructed, the routes should be placed to minimize damage to riparian vegetation and wetlands.

2. All new routes and staging areas constructed for the purpose of this project should be fully mitigated by restoring the natural topography and re-establishing native vegetation. Additionally, no public access should be allowed on new access routes to minimize the possibility that these routes become "established" through use after project completion. These non-public access routes should be properly gated to prevent non-authorized vehicular access.

3. As much as possible, material for construction of brush fences, root wads and kicker/spur dikes should be obtained on-site or from a source certified as disease free. If a secondary source of these items is required, this source should be approved by the Wyoming Game and Fish Department, Fisheries Section, to minimize the chance for fish disease transmission.

4. To protect nesting bald eagles, ospreys, great blue herons and other avian species, as well as migrating whooping cranes and common loons, no construction activities should begin prior to August 15. This includes construction of any new access routes and staging areas, movement of equipment to project areas and long-term survey team activity. Should no bald eagles nest within one mile of the project area, work may begin earlier than August 15 *after* consultation with the U.S. Fish and Wildlife Service. This consultation is necessary to ensure no other nesting migratory birds will be impacted by construction activity.

5. To protect wintering big game and trumpeter swans, all construction activity should be concluded by November 15. This includes removal of all associated equipment. Site visits to these areas after November 15 should be limited to only those absolutely necessary for project administration. If work cannot be completed by this date, or if big game have not begun moving into the area due to fair weather conditions, work may continue after November 15. However, this continuation can only occur *after* concurrence is received by the Wyoming Game and Fish Department.

6. All garbage, including food, should be removed from the project areas daily to discourage grizzly bears from entering the area. Bear proof trash and food storage containers should be provided to construction crews.

7. All construction and associated activities should be restricted to the area between levees to minimize potential damage to spring creeks, side channels and oxbows. For Area 1, all work

should be restricted to the river channel and immediately adjacent bank. Access to Area 2 should avoid damage to all spring creeks and the access route may require approval by a biologist to avoid unnecessary damage.

8. All equipment necessary for instream use should be thoroughly examined and serviced to minimize the potential for discharge of petroleum products into the Snake River. All equipment should be serviced off-site to prevent accidental spills of petroleum products into the River.

9. All activities should be performed in a manner that meets State and Federal water quality standards.

10. Borrow areas, if necessary, should be located outside the riparian corridor and avoid important fish and wildlife habitat.

11. Officials in charge of on-site construction should provide construction schedules by Area to local fishing outfitters. All efforts should be made to keep affected outfitters informed of changes in construction schedules.

12. A monitoring program for all restoration areas should be established to determine the effectiveness of this project. Monitoring should continue for a minimum of 10 years.

13. If annual maintenance of the protection/enhancement structures if necessary, this maintenance should be conducted in late summer to minimize potential impacts to nesting bald eagles, raptors and other migratory birds, and to wintering big game and trumpeter swans. If maintenance must be conducted outside the late summer period, the party responsible must work with either the U.S. Fish and Wildlife Service (bald eagles, migratory birds, raptors) or the Wyoming Game and Fish Department (big game) to ensure the proposed activities will not negatively impact these species.

14. Although this project will assist in restoration of limited areas of fish and wildlife habitat, a system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by levees along the Snake River. A riparian maintenance plan should be developed by an interdisciplinary team to preserve the diversity and value of this ecosystem.

Summary of Findings and Service Position:

Construction of levees along the Snake River near Jackson Hole, Wyoming, and the resultant concentration of water flows has caused extensive erosion, resulting in loss of aquatic and terrestrial wildlife habitat and significantly changing the character of the Snake River ecosystem (U.S. Fish and Wildlife Service 1990). The proposed project, if successful, will provide

environmental and wildlife habitat restoration of riverine, wetland and riparian habitats within four selected study areas on the Snake River.

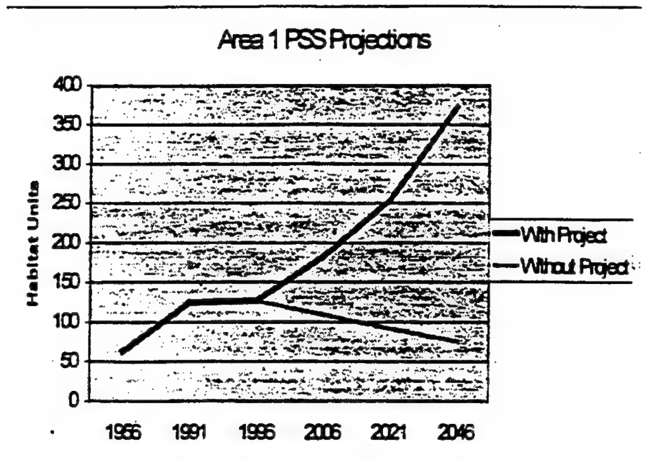
This project will benefit many species dependent on riparian habitat and facilitate restoration of the Snake River ecosystem within the four study areas. Specific examples include cottonwood regeneration for future bald eagle nesting and roosting sites, resting pools and habitat stability for the Snake River cutthroat trout, and restored habitat diversity for numerous passerines and mammals, including big game species. Impacts from construction and access will be minimal and will be offset by the anticipated benefits.

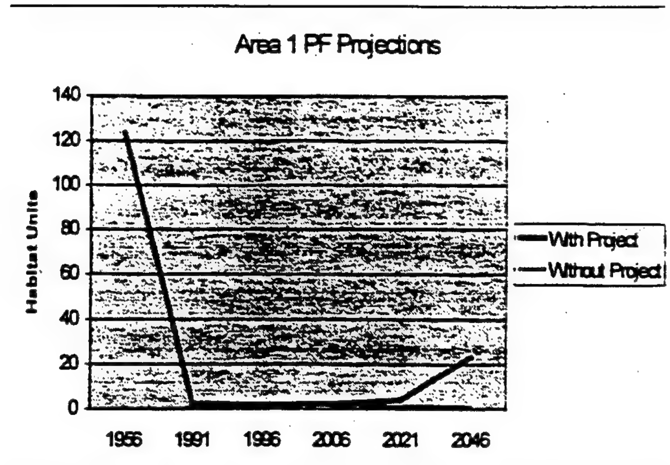
This project will result in an improvement of the riparian community impacted from extensive levee construction. Although the project is too limited in extent to fully offset past impacts of levee construction and maintenance, it is a very positive step toward restoring fish and wildlife habitat in this river system. The demonstration project proposed by the Teton County Natural Resources District is to determine if the proposed restoration techniques can accomplish large scale restoration efforts, and to stabilize islands, banks and channels in the limited demonstration area. The U.S. Fish and Wildlife Service supports this project.

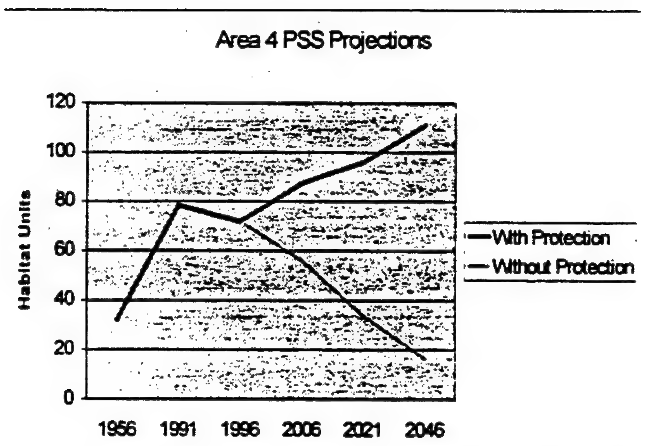
APPENDIX C

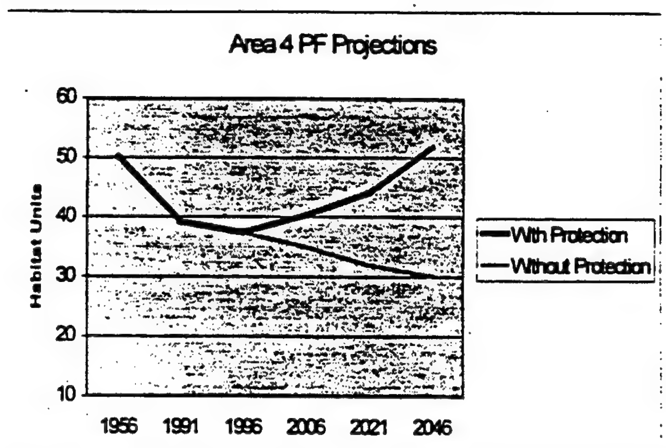
AQUATIC AND TERRESTRIAL BENEFITS WITH AND WITHOUT PROJECT BY AREA

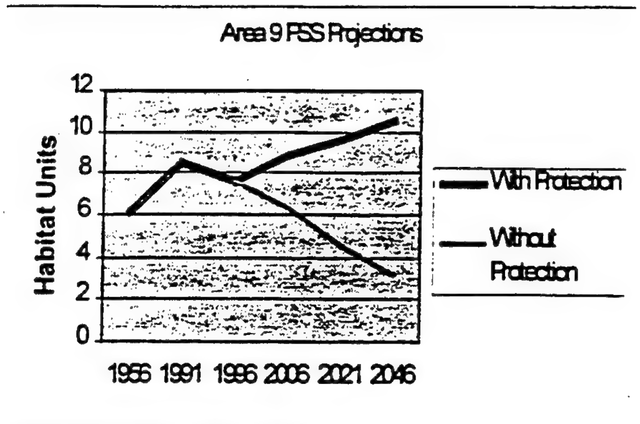
Site Specific Habitat Development Projections.







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6
4
2
0
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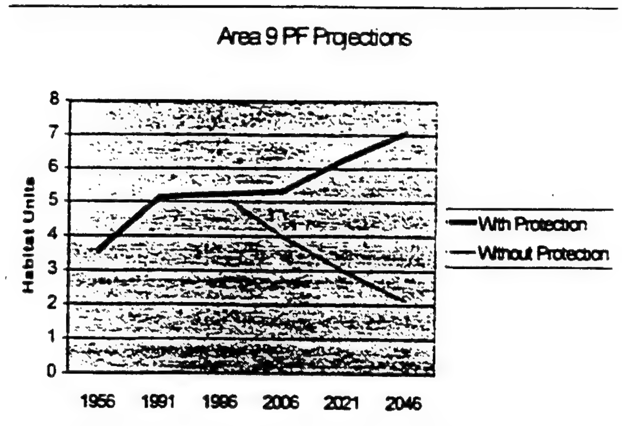
With Protection
Without Protection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4
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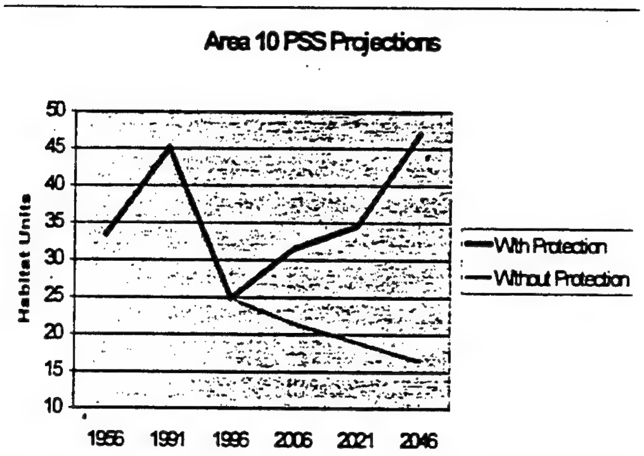
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45
40
35
30
25
20
15
10
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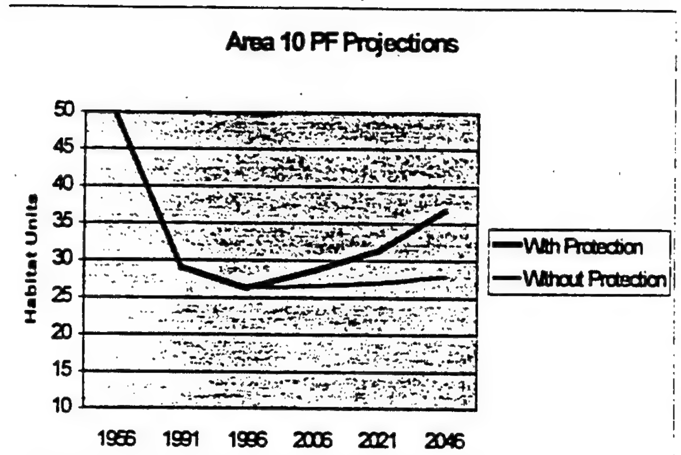
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Habitat Units
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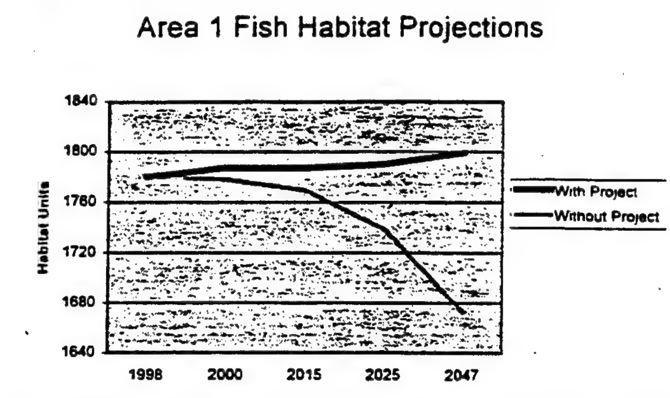
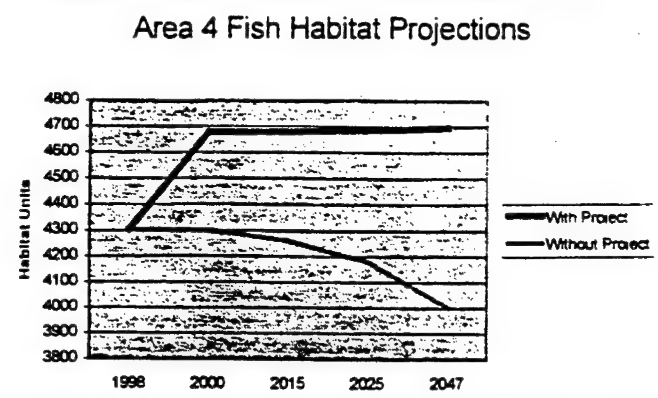
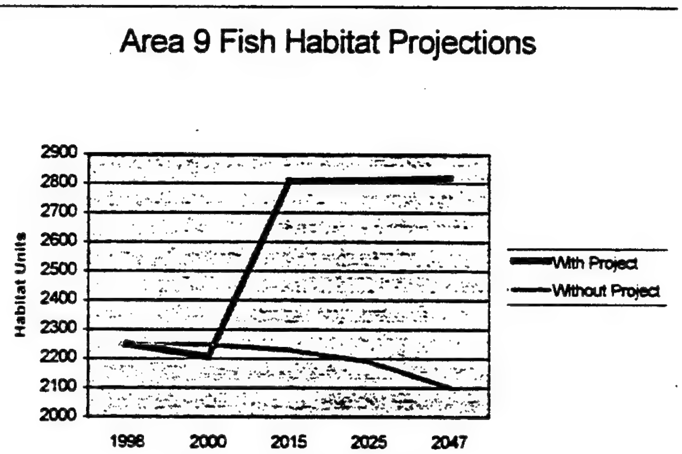
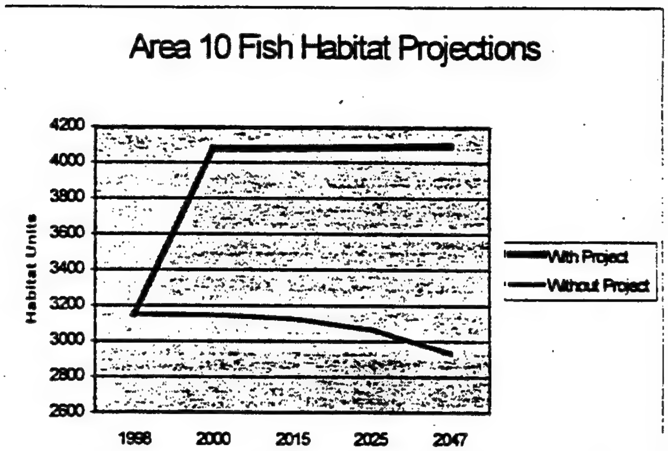
With Protection
Without Protection

Site Specific Fish Resting Habitat Development Projections.









APPENDIX D

CULTURAL RESOURCE CONCURRENCE LETTER FROM SHPO

DIVISION DIRECTOR
Karyl Denison Robb, Ph. D.

WYOMING

DIVISION OF CULTURAL RESOURCES

State Historic Preservation Office
6101 Yellowstone Road
Cheyenne, WY 82002

(307) 777-7697
FAX (307) 777-6421

COPY

February 11, 1997

Mr. Carl J. Christianson
Chief, Environmental Resources Branch
Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla, WA 99362-1876

RE: Jackson Hole Environmental/Habitat Restoration Project Along the Snake River; SHPO #1289RLE055

Dear Mr. Christianson:

Karen Kempton of our staff has received information concerning the aforementioned project. Thank you for allowing us the opportunity to comment.

We have reviewed the project report and find the documentation meets the Secretary of the Interior's Standards for Archaeology and Historic Preservation (48 FR 44716-42). No sites meeting the criteria of eligibility for the National Register of Historic Places will be affected by the project as planned. We recommend the Corps of Engineers (COE) allow the project to proceed in accordance with state and federal laws subject to the following stipulation: if any cultural materials are discovered during construction, work in the area should halt immediately and the COE staff and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken.

This letter should be retained in your files as documentation of our determination of "no effect" for this project.

We would like to remind you that we have not yet received follow up information regarding the Jackson Hole Flood Protection Levee Access Improvements project for which we received a FONSI in late November 1996. In a letter dated January 17, 1995 we agreed with your recommendations calling for a Class III survey of the proposed project areas. We look forward to further consultation regarding that project.

Please refer to SHPO project control number #1289RLE055 on any future correspondence dealing with this project. If you have any questions, contact Karen Kempton at 307-777-6292 or Judy Wolf, Deputy SHPO, at 307-777-6311.

Sincerely,

Judy K. Wolf
for John T. Keck
State Historic Preservation Officer

JTK:KLK:jh

APPENDIX E

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

APPENDIX E

JACKSON HOLE, WYOMING, ENVIRONMENTAL
RESTORATION PROJECT
SECTION 404(b)(1) EVALUATION
(40 CFR 230 - dated December 24, 1980)

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APPENDIX E

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION PROJECT SECTION 404(b)(1) EVALUATION (40 CFR 230 - dated December 24, 1980)

1. PROJECT DESCRIPTION.

a. Location.

The proposed environmental restoration project would occur at four locations: Areas 1, 4, 9, and 10, near the towns of Wilson and Jackson in Teton County, Wyoming. Area 1 is located in Sections 13, 14, 23, and 24, Township 40 N., Range 117 W; Area 4 is located in Sections 2, 3, 10, and 11, Township 40 N., Range 117 W; Area 9 is located in Sections 13 and 24, Township 41 N., Range 117 W; and Area 10 is located in Sections 5, 6, and 7, Township 41 N., Range 117 W. (Refer to plate 1.)

b. General Description.

The U.S. Army Corps of Engineers (Corps) plans to restore wetland and riparian habitats in the Snake River in response to environmental resource impacts resulting from levees constructed along the Snake River at Jackson, Wyoming. Over time, the levees have significantly changed the physical character of the river system and contributed to the loss of environmental resources. The presence of the levees has reduced the size of the actual floodplain resulting in a degraded condition of the area between the levees. Most notable effects include changes in channel configuration, which have eliminated natural braiding and reduced the number and size of islands. Associated with this change is the constriction of the floodplain and concentration of flow between the levees, resulting in higher velocities through the area. The high-velocity flows erode the river bottom gravels, islands, and vegetation along the banks. Aquatic habitat effects include loss of spawning area for the Snake River fine-spotted cutthroat trout, difficult passage to spring creeks for fish spawning, and loss of low-energy resting habitat for fish. Wildlife habitat effects include loss of shrub-willow cottonwood riparian areas used by moose, elk, mule deer, furbearers, numerous small mammals, and various other wildlife species.

The proposed project would employ a variety of tools aimed at protecting and improving habitat in and along the designated stretch of the Snake River. The project would involve construction of channel stabilization pools, secondary channels, off-channel pools, eco fences (both rock and piling), spur dikes (bank barbs and kickers), rock grade control structures, and anchored root wad logs.

Cumulatively, the tools would involve temporary and permanent discharges of dredged material and permanent discharges of riprap.

Gravel removal would be used to increase channel capacity, and construct off-channel pools, secondary channels leading to and from the off-channel pools, and channel stabilization pools. These tools are intended to maintain channel stability, improve sediment transport, and diversify fish habitat. Gravel removal to increase channel capacity would compensate for discharges of dredged and fill material, thereby, ensuring the base flood flow capacity is maintained.

Eco fences would be employed to protect existing islands from erosion and to rebuild islands through deposition. Spur dikes would be placed to slow bank erosion and create in-water fish habitat. Rock grade control structures would be used to prevent erosion and protect existing riparian and aquatic habitat. Anchored root wad logs would also be used to protect existing islands and promote deposition in an attempt to restore eroded islands.

The shifting nature of the braided river is expected to have some effect upon the structures. The extent of effects would vary between structures and from site to site, depending upon river conditions. Some structures would likely require maintenance to ensure they continue to function as designed. The frequency of maintenance would be dictated by the extent of river effects upon the structures. Completed structures would be monitored to identify effects of river flows and the need for maintenance. Monitoring procedures for structure integrity and function and aquatic and terrestrial habitat changes would be contained in a monitoring plan that would be developed by the Corps prior to implementation of the project. Maintenance would likely be necessary for channel stabilization pools, secondary channels, off-channel pools, eco fences, and spur dikes. Typical maintenance activities might include: removal of gravel from off-channel pools and the upper end of secondary channels leading to the off-channel pools, removal of gravel from channel stabilization pools, measures to reset piles and reattach cables on piling eco fences, and the addition of large rock to rebuild eroded spur dikes. The quantity of materials necessary that perform maintenance to the various structures would depend upon the extent to which maintenance may be needed. Any discharges necessary to conduct maintenance would be consistent with the materials, methods, and disposal sites identified in the Jackson Hole, Wyoming, Environmental Restoration Project, Environmental Assessment, and this 404(b)(1) evaluation.

c. Purpose.

The purpose of the project is to restore fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of the Jackson Hole Flood Control Project, including levees constructed by non-Federal interests. The project is intended to preserve and enhance remaining terrestrial and aquatic habitat and

replace portions of habitat lost due to the effects of the levees upon the river system.

d. Description of Method for Dredging and Placement of Materials.

(1) General Description.

Gravel would be removed to compensate for reduction in channel capacity caused by discharges of fill material and deposition of sediments around the completed structures. Gravel removal would also be necessary in the construction of channel stabilization pools, off-channel pools, secondary channels, eco fences, rock grade control, and spur dikes. Riprap fill material would be used to construct eco fences, spur dikes, and rock grade control.

All work would be accomplished in a manner that would comply with Quality Standards for Wyoming Surface Waters and all terms and conditions detailed in the Federal Water Pollution Control Act §401 Certification from Wyoming Department of Environmental Quality, if issued. The Snake River is classified as Class 1 upstream of the Wyoming Highway 22 bridge. Areas 9 and 10 fall within this reach. Areas 1 and 4 are downstream of the bridge and fall within Class 2 surface waters. Classes 1 and 2 water carries basically the same water quality standards for protection of aquatic life. The standards most pertinent to this project require that turbidity increases downstream from the activity shall not exceed 10 Nephelometric Turbidity Units (NTU's) above background (upstream) levels. Currently, the standards do not allow for short-term increases in turbidity above this level. However, proposed changes to the regulations include allowance for short-term increases of turbidity made on a case-by-case basis. There is also a requirement for zone of passage, or a continuous water route that joins segments of a surface water body above and below a mixing zone. Such routes would be comprised of continuous flow with less than 10 NTU above background around the work site.

(a) Gravel Removal.

Gravel removal includes excavations to increase channel capacity and excavations to construct channel stabilization pools, off-channel pools and secondary channels. Gravel removal would be conducted either in the dry, above the level of the existing water surface flow, or within areas separated from surface flows by a temporary diversion or berm. Water diversion materials would be scooped from adjacent cobble, gravel, and sand deposits above the existing water surface flow and discharged to construct temporary diversion berms where needed to de-water excavation sites. Water diversion berms would specifically be used to alternately de-water channels at Area 9 north of the bridge to allow the channel capacity excavations to occur in non-flowing waters. Use of diversions at other locations would be dictated by site conditions that exist at excavation sites at the

time of construction. Following completion of work within the de-watered areas, the berm material would be scooped and transported to a permitted gravel processing facility for disposal.

Gravel removal would be accomplished using a track-mounted excavator, rubber-tired backhoe, or other similar equipment, along with trucks to transport the material to disposal and stockpile sites. The 4-inch plus cobble would be screened from the removed gravel and permanently discharged as dredged material below the ordinary high water mark (OHWM) to rearmor the bottom of the channel capacity, channel stabilization pool, off-channel pool, and secondary channel gravel removal sites. The excavated cobble, gravel, and sand may be temporarily stockpiled in the dry below the OHWM in preparation for screening. The 4-inch plus screened cobble material may also be temporarily stockpiled below the OHWM in preparation for rearmoring the gravel removal sites. Temporary stockpile sites would be gravel deposit areas free of vegetation. Cobble, gravel, and sand that would not be screened, as well as any excess 4-inch plus cobble, would be transported by truck to a permitted gravel processing facility for disposal prior to anticipated high flows. The channel bottom of channel capacity excavations, channel stabilization pools, and secondary channels would be armored with the 4-inch plus cobble. During low-flow periods, armor material would be placed in rows spaced 10 feet apart on center, aligning perpendicular to the channel centerline. The rows would have a cross-sectional area equivalent to 10 square feet. This would provide a volume of armor equivalent to a 1-foot-thick layer of armor on the channel bottom. The bottom of off-channel pools would be armored at the upper ends of the channels with a layer of 4-inch plus cobble, approximately 12 inches thick.

(b) Secondary Channels.

Secondary channels would provide water to and from off-channel pools. Material would be scooped with an excavator and side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. The dredged material would be evenly spread over the gravel bar using the excavator. However, if dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Disposal on adjacent gravel deposits would be below the OHWM, in the dry and above the low flow of the river.

(c) Off-channel pools.

An excavator would scoop gravel from the pool site, side-cast and spread the material onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. The dredged material would be evenly spread over the gravel bar. However, if dump truck access routes are available, which would

have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Disposal on adjacent gravel deposits would be below the OHWM, in the dry and above the low flow of the river.

(d) Eco Fences.

Two different types of fences may be used: piling eco fences and rock eco fences. An excavator may remove and reposition cobbles and gravel to prepare the site for driving the piles. No discharges of fill material would occur in connection with the piling eco fences. Rock eco fences, constructed of riprap, would require repositioning of cobble, gravel, and sand to embed the structure into the channel bottom. Riprap would be trucked to the site and dumped directly into the excavated site.

(e) Bank Barbs.

Bank barbs would be built of riprap and would extend up to 30 feet into the river from the adjoining levee. Gravel and cobble excavated to embed the structure would be transported to a permitted gravel processing facility for disposal. Equipment used to excavate for the barbs and to place riprap would sit atop the levee and would maneuver onto the top of the barb when necessary.

(f) Kickers.

Kickers would be composed of riprap armor extending up to 60 feet from the adjoining levee. Gravel and cobble excavated to embed the kickers would be used as the random core fill material. Excavated material would be temporarily stockpiled out of the channel on the adjacent levee. The structure would be tied into the adjoining levee. Equipment used to excavate for the kickers and to place riprap would sit atop the levee and would maneuver onto the top of the kicker, when necessary.

(g) Rock Grade Control.

Existing cobble, gravel, and sand would be removed to a standard uniform depth of 3 feet below the ground surface by an excavator. The material would be scooped and transported off-site to a gravel processing facility for disposal. The area would then be graded and filled with riprap to match existing topography. Riprap would be transported to the site by truck, dumped, and spread using an excavator to achieve uniform depth. Material would be placed below the OHWM, in the dry, and above the level of existing water flows.

(h) Anchored Root Wad Logs.

Root wad logs would be obtained from along the river channel within the four project areas. Equipment would be used to either transport or drag the logs to the installation site. Root wad logs that must be transported across low-flow channels would be dragged across using a cable winch. Minor repositioning of cobble, gravel, and sand may be required to partially embed root wad logs into the channel bottom.

e. Description of the Proposed Discharge Site.

(1) Location.

The locations of project Areas 1, 4, 9, and 10 are identified in paragraph 1.a. above and on plate 1.

(a) Gravel Removal.

Discharges of dredged 4-inch plus cobble would occur upon the disturbed bottom surface of the channel capacity and channel stabilization pool excavation sites. Any excavated cobble, gravel, and sand temporarily stockpiled in preparation for screening, and temporarily stockpiled screened cobble, would be placed above the existing water level, in the dry, upon adjacent gravel deposits. Excavated material that would not be screened would be transported from the channel and disposed at a permitted gravel processing facility in uplands.

(b) Secondary Channels.

Dredged cobble, gravel, and sand would either be permanently side-cast on adjacent, unvegetated gravel deposits or transported to a permitted gravel processing facility in uplands for disposal.

(c) Off-channel pools.

Dredged cobble, gravel, and sand would either be permanently side-cast on adjacent, unvegetated gravel deposits or transported to a permitted gravel processing facility in uplands for disposal.

(d) Eco Fences.

Discharges of dredged material would occur when the cobble, gravel, and sand is smoothed, leveled, or repositioned to facilitate placement of both rock and piling eco fences. Gravel would be moved only as necessary to partially embed the eco fences into the river bottom. The minor amount of removed

material would be side-cast and spread around and adjacent to the structures as a permanent discharge of dredged material.

(e) Bank Barbs.

Dredged cobble, gravel, and sand may be temporarily stockpiled on the adjacent levee, above the OHWM. The dredged material would be transported to a permitted gravel processing facility for upland disposal. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site.

(f) Kickers.

Dredged cobble, gravel, and sand would be temporarily stockpiled on the adjacent levee, above the OHWM. Permanent discharges of the dredged cobble, gravel, and sand would occur below the OHWM as core material for each kicker. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site.

(g) Rock Grade Control.

Dredged cobble, gravel, and sand would be transported to a permitted gravel processing facility upland for disposal. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site. Rock grade control to be constructed in Area 9 only, based on current river conditions.

(h) Anchored Root Wad Logs.

Permanent discharges of dredged material would occur when the cobble, gravel, and sand is smoothed, leveled, or repositioned to facilitate anchoring of root wad logs. Gravel would be repositioned only as necessary to partially embed the root wad logs into the gravel deposits.

(2) Type of Site.

Areas 1, 4, 9, and 10 all consist of a cobble, gravel, and sand substrate. All work affecting the substrate would occur in the dry with the exception of the discharge of dredged material to construct temporary water diversions, excavations, and discharges of dredged and fill material to construct spur dikes, and discharge of dredged 4-inch plus cobble to armor certain excavation sites. Spur dike and water diversion construction would occur in the flowing portion of the low-flow stream. Excavation sites to be armored with 4-inch plus cobble would likely contain water that would have infiltrated through the cobble, gravel, and sand substrate. The water would be separated from surface flows of the low-flow stream by construction of a temporary water diversion.

(3) Type of Habitat.

The Snake River has two separate classifications as a surface water of the State of Wyoming. The portion of the river upstream of the Wyoming Highway 22 bridge (which includes Areas 9 and 10) is classified as a Class 1 water. That portion of the river downstream of the bridge, which includes Areas 1 and 4, is Class 2 water.

Water quality in the upper Snake River and its tributaries is generally high most of the year. Data reported in the 1996 and 1997, U.S. Geological Service (USGS) Water Resources Data, Idaho, Volume 1, show that at the Snake River at Moose, Wyoming, gage site maximum water temperatures usually remain below 60.8 °F; pH generally ranges in value from 7.8 to 8.4; dissolved oxygen saturation is always near 100 percent; specific conductance ranges from 100 to 200 micro Siemens per centimeter (µS/cm); nitrate nitrogen is generally below 0.12 parts per million (ppm) as nitrogen (N); ammonia nitrogen below 0.08 ppm as N; orthophosphorous is generally below 0.020 ppm as phosphorus (P); and total phosphorous concentrations are usually less than 0.20 ppm as P. Measured suspended sediment concentrations are less than 30 mg/l during low-flow periods. Turbidity is generally the greatest water quality problem and increases with high runoff. Sources of turbidity at high flows are generally erosion from surface runoff and tributaries. Jackson Lake influences the channel regime in the upper part of the river by removing all but the finest suspended sediment from the water. All of the bedload in the lower river is derived from tributary streams and from erosion of the channel and channel banks downstream of Jackson Lake.

(4) Timing and Duration of Discharge.

Construction of the project would begin in August 2001 and continue into 2004. Construction would occur at only one of the four sites each year. Discharges of dredged and fill material would occur during low river flows. Low-flow periods generally occur from October 15 until March 15.

f. General Description of Dredged or Fill Material.

(1) General Characteristic of Material.

(a) Dredged Material.

Materials to be excavated at Areas 1, 4, and 10 are generally composed of a cobble layer on the surface, underlain by poorly graded gravel with sand. Area 9 consists of the same cobble layer; however, it is underlain by a well-graded gravel with sand. The cobble layer at all four areas is approximately 12 inches thick with a maximum particle size of 12 inches.

(b) Discharges of Dredged Material.

Both temporary and permanent discharges of dredged cobble, gravel, and sand would occur below the OHWM. In addition, permanent discharges of 4-inch plus cobble dry screened from dredged cobble, gravel, and sand would also occur below the OHWM.

(c) Fill Material.

Permanent discharges of fill material would consist of riprap and root wad logs. Riprap would be clean angular rock, free of fines, with an average diameter of 2 feet. Root wad logs would consist of irregular shaped tree trunks with the root wad attached. A minor amount of soil may still be attached to the root wad.

(d) Discharges of Fill Material.

Riprap fill would be used to construct rock eco fences, spur dikes, and rock grade control structures.

(2) Quantity of Material and Size of Excavation and Discharge Areas.

Multiple numbers of structures and varying amounts of excavation and discharges would occur within each of the four project areas. The quantities identified below represent approximate maximum quantities. Actual quantities could exceed the estimates, but are most likely to be less than the maximum identified.

(a) Gravel Removal to Construct Channel Stabilization Pools and Maintain Channel Capacity.

Gravel would be removed to construct channel stabilization pools and to maintain channel capacity within the 100-year event base flood capacity. The 4-inch plus cobble would be screened from the removed gravel and permanently discharged as dredged material below the OHWM to rearmor the bottom of the channel capacity and channel stabilization pool gravel removal sites.

The excavated cobble, gravel, and sand may be temporarily stockpiled below the OHWM in preparation for screening. The 4-inch plus cobble screened material may also be temporarily stockpiled below the OHWM in preparation for rearmoring the bottom of the channel stabilization pools and channel capacity excavation sites. Temporary stockpile sites would be gravel deposit areas free of vegetation and above the elevation of the flowing water. Cobble, gravel, and sand not screened would be transported by truck to a permitted gravel processing facility for disposal. Refer to tables E-1 and E-2 for excavation quantities and size of areas.

Table E-1. Channel Capacity Excavation and Channel Stabilization Pools. Gravel Removal Quantities and Size of Areas.

	Area 1	**Area 4**	**Area 9**	**Area 10**
Channel Capacity Excavation	37,000 cy[1/]	128,800 cy	130,000 cy	9,630 cy
	16 acres	17.4 acres	31.0 acres	1.5 acres
Channel stabilization pool Excavation	97,000 cy	429,600 cy	0 cy	272,000 cy
	19 acres	33.1 acres	0 acres	19 acres

[1/] Cubic yards.

Table E-2. The 4-Inch Plus Cobble to Armor Channel Stabilization Pools and Channel Capacity Excavation Sites. Discharge Quantities and Size of Areas.

	Area 1	**Area 4**	**Area 9**	**Area 10**
Channel Capacity Excavation	7,350 cy	25,760 cy	26,000 cy	1,926 cy
	16 acres	17.4 acres	31.0 acres	1.5 acres
Channel stabilization pool	19,400 cy	85,920 cy	0 cy	54,400 cy
	19 acres	33.1 acres	0 acres	19 acres

(b) <u>Secondary Channels</u>.

Cobble, gravel, and sand would be excavated to enhance or construct secondary channels. This material would be side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. However, if dump truck access routes are available that would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Refer to tables E-3 and E-4 for quantities and size of area.

Table E-3. Secondary Channels. Excavation Quantities and Size of Areas.

	Area 1	**Area 4**	**Area 9**	**Area 10**
Excavation to Construct Secondary Channels	700 cy	1,120 cy	500 cy	0 cy
	0.14 acre	0.23 acre	0.1 acre	0 acres

Table E-4. Secondary Channels. Discharge Quantities and Size of Areas of 4-Inch Plus Cobble to Armor Secondary Channels.

	Area 1	Area 4	Area 9	Area 10
Discharge of 4-inch Plus Cobble	140 cy	0 cy	100 cy	0 cy
	0.14 acre	0 acres	0.1 acre	0 acres

(c) Off-Channel Pools.

Cobble, gravel, and sand would be excavated to enhance or construct off-channel pools. This dredged material would be side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. However, if dump truck access routes are available that would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Refer to tables E-5 and E-6 for quantities and size of areas.

Table E-5. Off-Channel Pools. Excavation Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Construct Pools	48,000 cy	32,000 cy	0 cy	12,000 cy
	9.9 acres	5 acres	0 acres	2.5 acres

Table E-6. Off-Channel Pools. Discharge Quantities and Size of Areas of 4-inch Plus Cobble to Armor Off-Channel Pools.

	Area 1	Area 4	Area 9	Area 10
Discharge of 4-Inch Plus Cobble	9,600 cy	6,400 cy	0 cy	2,400 cy
	9.9 acres	5 acres	0 acres	2.5 acres

(d) Eco Fences.

The quantity of gravel removal necessary to embed eco fences into the gravel deposits would depend upon the site selected for placement of the structure. Gravel would be moved only as necessary to embed eco fences into the river bottom or create an area for driving piles. The removed material would be temporarily stockpiled adjacent to the excavation site and subsequently used to permanently embed the completed structures. No discharges of fill material are necessary for construction of pile supported eco fences. Refer to table E-7 for quantities and size of areas.

Table E-7. Eco Fences. Excavation and Discharge Quantities and Size of Areas. Numbers Shown under Each Type of Eco Fence Represent the Combined Quantity and Combined Size of All Structures in that Category.

	Area 1		**Area 4**		**Area 9**		**Area 10**	
Type of Eco fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence
Excavation to Embed Structure	1,700 cy	5,450 cy	28,330 cy	9,241 cy	250 cy	670 cy	1,800 cy	5,860 cy
	3,660 ft[1/]	3,660 ft	6,210 ft	6,210 ft	430 ft	430 ft	3,930 ft	3,930 ft
Discharge of Dredged/ Excavated material	1,700 cy	5,450 cy	28,330 cy	9,241 cy	250 cy	670 cy	1,800 cy	5,860 cy
	3,660 ft	3,660 ft	6,210 ft	6,210 ft	430 ft	430 ft	3,930 ft	3,930 ft
Discharge of riprap	0 cy	7,100 cy	0 cy	12,065 cy	0 cy	850 cy	0 cy	7,650 cy
	0 ft	3,660 ft	0 ft	6,210 ft	0 ft	430 ft	0 ft	3,930 ft

[1/] Feet.

(e) Bank Barbs.

Cobble, gravel, and sand would be excavated to embed bank barbs into the riverbed. The material would be temporarily stockpiled on the adjacent levee, above the OHWM. This material would be transported to a permitted gravel processing facility for upland disposal. Riprap fill material would be permanently discharged below the OHWM to construct bank barbs. Refer to table E-8 for quantities and size of areas.

Table E-8. Bank Barbs. Excavation and Discharge Quantities and Size of Areas.

	Area 1	**Area 4**	**Area 9**	**Area 10**
Excavation to Embed Bank Barbs	0 cy	100 cy (combined total for 5 structures)	140 cy (combined total for 7 structures)	240 cy (combined total for 12 structures)
	0 acres	0.1 acre	0.1 acre	0.3 acre
Discharge of Riprap	0 cy	200 cy (combined total for 5 structures)	280 cy (combined total for 7 structures)	480 cy (combined total for 12 structures)
	0 acres	0.1 acre	0.1 acre	0.3 acre

(f) Kickers.

Cobble, gravel, and sand would be removed to embed kickers into the river bottom. The material would be temporarily stockpiled on the adjacent levee, above the OHWM. This dredged material would be permanently discharged back into the river as core material for kickers. Riprap fill material would be

permanently discharged below the OHWM to construct kickers. Refer to table E-9 for quantities and size of areas.

Table E-9. Kickers. Excavation and Discharge Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Embed Kickers	0 cy	1,000 cy (combined total for 5 structures)	1,600 cy (combined total for 8 structures)	2,600 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre
Dredged Material Discharge	0 cy	1,000 cy (combined total for 5 structures)	1,600 cy (combined total for 8 structures)	2,600 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre
Discharge of Riprap	0 cy	750 cy (combined total for 5 structures)	1,200 cy (combined total for 8 structures)	1,950 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre

(g) Rock Grade Control.

Rock grade control would be constructed in Area 9 only, based on current river conditions. Prior to the start of construction, river conditions may create new areas that warrant rock grade control. Approximately 3,500 cy of cobble, gravel and sand would be excavated to embed riprap into the river bottom to construct rock grade control at Area 9. This material would be scooped and transported to a permitted gravel processing facility in uplands for disposal. Approximately 3,500 cy of riprap fill material would be permanently discharged below the OHWM. Rock grade control would encompass approximately 0.7 acres at Area 9.

(h) Anchored Root Wad Logs.

The quantity of gravel removal necessary to position and anchor root wad logs in the gravel bed would depend upon the site selected for placement of the structure. The quantity is expected to be minimal. Gravel would be moved only as necessary to position and partially embed the root wad logs. No discharges of fill material are necessary for placement of anchored root wad logs.

(3) Source of Material.

The Snake River is the source of cobble, gravel and sand that would make up the permanent and temporary discharges of dredged material. Riprap fill would be obtained from an upland site to be selected by the construction contractor. Root wad logs would be obtained from the existing assortment of downed woody debris located within the four project areas. If needed, additional root wad logs may be obtained commercially from Walton Quarry, located near Area 9 or Jackson Lake.

2. FACTUAL DETERMINATIONS.

a. Physical Substrate Determinations.

(1) Substrate Elevation and Slope.

In 1996, the active channel substrate elevation in Area 1 is approximately 6,000 feet National Geodetic Vertical Datum (NGVD) of 1929 and channel slope was 14.4 feet per mile. Area 4 has an approximate elevation of 6,075 feet NGVD and slope of 8.4 feet per mile. The Area 9 approximate elevation is 6,160 feet NGVD with a slope of 18.2 feet per mile. Area 10 elevation is approximately 6,240 feet NGVD and slope is about 19.8 feet per mile.

(2) Substrate Particle Size.

Surface materials vary widely from sandy silt to large 6- to 10-inch cobble with the largest materials generally located in the active channel bottoms, finer materials located in protected areas downstream of vegetation or debris, and areas distant from the main channel.

Underneath the surface layer, which may range from 6 to 12 inches, the material consists of a much more uniformly distributed mix of sand through cobble sizes. The 4-inch plus cobble make up about 5 percent of the subsurface materials in Areas 1 and 4 and about 15 percent to 18 percent of the subsurface materials in Areas 9 and 10 (based on samples collected at each site).

(3) Dredged/Fill Material Movement.

The project sites are in a reach of the Snake River that is highly unstable. Though the measures proposed are meant to improve stability, the inherent nature of high velocity-streams would result in some displacement of materials placed during construction. Cobbles placed to provide streambed armor in channel capacity excavation areas would be redistributed over the bottom surface by high flows. Materials that may be side-cast onto dry gravel bars during

construction of channel stabilization pools, off-channel pools, and secondary channels would likely move when river flows are high enough to influences those areas. The rock grade control is intended not to move but to prevent erosion or down-cutting of the channel. However, the riprap material placed there may move until it settles. Anchored root wad logs, rock eco fences, and piling eco fences are intended to be relatively permanent fixtures. As with the other project techniques, they would be monitored for movement. Bank barbs and kickers are expected to experience some erosion by impingement by high-velocity flows. Due to the large angular nature of the riprap material, which would be used to construct them, it is not likely that the fill material would move very far.

(4) Physical Effects on Benthos.

Excavations for channel capacity, off-channel pools, channel stabilization pools, secondary channels, rock eco fences, rock grade control, and spur dike kickers could affect the benthos, by removing and/or destroying them. Benthos could also be affected by discharges of dredged material placed back into the channel capacity, side pool, and channel stabilization pool excavation sites (although these areas will have just been disturbed). Discharges of cobble, gravel and sand resulting from off-channel pool and secondary channel excavations may also affect benthos (although this material may be spread on the adjacent gravel bars above the low flow of the channel, and discharges of riprap to construct spur dikes and eco fences). The benthos impact would be somewhat reduced due to the ability of some benthic invertebrates to migrate with the water. There would likely be a lot of invertebrate drift downstream to nonimpacted areas. Recolonization of disturbed areas is expected to occur soon after disturbance, whenever the first flows begin over those areas. In areas where measures would be taken to increase sedimentation rates (*e.g.*, downstream of eco fences along island shorelines) sedimentation rates are expected to be slow enough to allow escape of macro-invertebrates.

(5) Other Effects.

No other effects are anticipated.

(6) Actions Taken to Minimize Impacts.

A Corps biologist would be on-site to coordinate with the contractor. All in-water work would be conducted during low-water flows in the Snake River. Low water generally occurs from approximately October through April.

b. Chemical Description of Materials.

Due to the coarse nature of all dredge and fill materials, which would be handled during this project, no chemical analyses have been performed. A Tier 1

evaluation indicated no need for further assessment of contaminants in the substrate. However, low concentrations of dissolved atrazine (0.005 µg/l and less) were reported in water sampled in 1996 and 1997 by the USGS at the Snake River at Moose, Wyoming, Station (USGS Water-Data Report ID-96-1 and ID-97-1). There is no reason to believe that the sediments contain any chemicals in concentrations of concern. The fill material that would be brought in (riprap) would be free of chemical contaminants.

c. Water Salinity, Circulation, and Fluctuation Determinations.

(1) Water.

(a) Salinity.

No effect.

(b) Water Chemistry.

Slight decreases in dissolved oxygen may occur during in-water work periods, but the spatial extent would be small and duration would be short. Compliance with Wyoming Surface Water Quality Standards would result in only acceptable changes in water quality. No discharges of chemicals are proposed as part of this project.

(c) Clarity.

In-water work would result in increases in suspended sediments in the water column. A turbidity monitoring program would be implemented during any in-water construction activities. Restricting decreases in water clarity by limiting increases in turbidity to no more than 10 NTU's above background would ensure that visible plumes of water, with lessened clarity, do not extend far downstream and are short lived. When the river is returned to flow over an excavated area, there would be an initial increase in turbidity as the flow picks up the fine material from the surface. This should be of very short duration, perhaps a few hours.

(d) Color.

Changes in water color that result from discharges of dredged or fill material would be linked to changes in water clarity and would be short lived.

(e) Odor.

No effect.

(f) Taste.

There are no known municipal or private potable water supply intakes immediately downstream of the four project areas; thus taste is not a relevant factor.

(g) Dissolved Gas Levels.

The project is not expected to have a substantial effect on total dissolved concentrations. Small, short-lived dissolved oxygen reductions could result in very minor reductions in total dissolved gas pressures.

(h) Nutrients.

Disturbance of sediments during in-water excavations and dissolution during in-water disposal may increase water column concentrations of inorganic and organic nutrients. Rapid dilution would occur. Excavations and discharges in the dry would have no impact upon nutrients.

(i) Eutrophication.

Creation of low-velocity habitat may result in increased biological productivity in those areas. This would be a desirable effect of this project. No negative eutrophication effects are expected.

(j) Others.

As off-channel pools are constructed, the temperature of any standing water that becomes exposed would increase with exposure to warm air temperatures and daylight. However, because these areas should be devoid of susceptible macroorganisms due to lack of connection with flowing water and prior desiccation, there should be no effect. Water from these pools would mix with cooler water from supply channels before entering the river.

(2) Current Patterns and Circulation.

(a) Current Pattern and Flow.

The project is designed to provide marked beneficial effects by changing flow patterns, depths, and velocities without impeding flows. No negative impacts are expected.

(b) Velocity.

No negative impacts are expected. Localized velocity decreases are expected. Positive impacts may occur if structures slow velocities sufficiently to allow deposition of a layer of soil and subsequent establishment of vegetation.

(c) Stratification.

No effect.

(d) Hydrologic Regime.

The project would not effect the normal river flows through the sites.

(3) Normal Water Fluctuations.

Normal water level fluctuations are affected by levees located throughout this stretch of the Snake River. It is assumed that the current situation represents the normal fluctuations. Velocities are increased through this stretch because of the levees. Because channel capacity excavations would compensate for discharges and deposition, the project should have minimal effect upon normal water fluctuations. No water would be taken out or added to the river due to the project. However, modifications to the streambed would influence the frequency and duration of cobble bar inundation and saturation in affected areas.

(4) Actions that will be Taken to Minimize Impacts.

No further actions will be necessary.

d. Suspended Particulate/Turbidity Determinations.

(1) Expected changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Site.

Test samples of the substrate in this reach of the river revealed less than 2 percent of the sediment to be very fine sand or smaller fines. Turbidity would be monitored and work modified to comply with water quality standards. Any effects that may result should be localized and dissipated rapidly; therefore, no significant reduction in primary productivity should occur.

(2) Effects (Degree and Duration) on Chemical and Physical Properties of the Water Column.

(a) Light Penetration.

Any increased turbidity occurring as a result of the proposed action would cause short-term reduction in light penetration. However, due to the anticipated limited effects upon the water column, effects on chemical and physical properties would be minor to negligible and short-lived. Also, any increases in turbidity above the standard would result in work stoppage until the turbidity returns to background levels. Due to the limited presence of fines in the river, little reduction in light penetration due to increased turbidity is expected.

(b) Dissolved Oxygen.

Slight reductions in dissolved oxygen concentrations may occur due to decomposition of resuspended organic matter but will be short lived.

(c) Toxic Metals and Organics.

The materials to be moved are relatively coarse in nature, therefore, should not contain contaminants. In addition, there are no known sources of contaminants in the area.

(d) Pathogens.

No effect.

(e) Aesthetics.

A minor turbidity plume would likely occur in the low-flow channel during in-water work. This plume is expected to be noticeable only during construction and should only extend a short distance downstream before dissipating. Effects of the increased turbidity are expected to be minor due to monitoring and modification of work in compliance with water quality standards. Turbidity increases lasting for a short time can be expected when flows first pass over areas that have been worked in the dry.

(f) Other.

No other effects.

(3) Effects on Biota.

(a) Primary Production. Photosynthesis.

Due to the limited presence of fines in the river. little reduction in light penetration due to increased turbidity is expected. Any effects that may result should be localized and dissipated rapidly, therefore, no significant reduction in primary productivity should occur. Increases in primary productivity may be expected in areas where low velocity habitat is enhanced (*e.g.*, off-channel pools, channel stabilization pools, and spur dikes).

(b) Suspension/Filter Feeders.

Prey and predators displaced from the work areas would find similar suitable habitat in the immediate vicinity of the disturbance. Invertebrate drift would increase from in-water work areas, enhancing downstream foraging during construction. Recolonization would occur rapidly. Zones of passage required around mixing zones to comply with water quality standards would be provided.

(c) Sight Feeders.

Sight feeding could be impacted within the turbidity plumes immediately downstream of in-water work. However, plumes of reduced water clarity would rapidly dissipate so impacts are expected to be minimal.

(4) Actions Taken to Minimize Impacts.

No further actions will be necessary.

e. Contaminant Determinations.

(1) Due to the coarse nature of the dredged and fill materials to be handled during this project, no direct contaminant analyses are required. There is no reason to believe that the substrate contains sufficient levels of chemical contaminants to cause concern.

f. Aquatic Ecosystem and Organism Determinations.

(1) Plankton Effect.

No effect.

(2) Benthos Effects.

Benthic communities in the construction area would be disturbed. buried, and/or destroyed. Upon completion of the project, adjacent benthic communities should colonize excavation sites and sites of discharged dredged and fill material.

(3) Nekton Effects.

Mobile aquatic organisms would likely move out of the immediate area of the proposed in-water work, but would return upon completion of the proposed actions.

(4) Aquatic Food Web Effects.

Disturbance and destruction of benthic communities at the proposed sites due to disturbances created by the project would cause local reduction in the available food supply to higher organisms resident to the sites. This would displace these resident populations to surrounding water until the food chain is reestablished. The benthic recolonization time period, and its impact upon the sites total food web should be negligible due to the limited scope of in-water work.

(5) Special Aquatic Site Effects.

(a) Sanctuaries and Refuges.

The National Elk Refuge is located approximately 3 miles east of the four project areas and Wyoming Game and Fish Department's South Park Habitat Unit is located east of Area 1. The project is not expected to have any effect upon sanctuaries and refuges.

(b) Wetlands.

Wetlands would not be adversely affected by excavation, discharges of dredged, or fill material, or equipment access. All work would occur in unvegetated cobble, gravel, and sand depositional areas located below the OHWM of the Snake River. The project would provide long-term potential for wetland establishment in areas of deposition downstream of anchored root wad logs and some eco fences. Silts deposited below these structures would provide suitable seedbed sites for natural vegetation regeneration. Off-channel pools would also provide opportunity for wetland establishment.

(c) Mud Flats.

Not applicable.

(d) Vegetated Shallows.

Not applicable.

(e) Riffle and Pool Complexes.

Kickers would create pools soon after they are installed. Anchored root wads have the potential to create additional pool areas depending on the channel migration pattern. Protection of existing vegetated islands may also provide more pool habitat over time by slowly releasing woody debris instead of many trees being washed away in one high-water event. Trees that fall into the river can be an important element of quality pools. The proposed project may cause an increase in the pool-to-riffle ratio of the project areas.

(6) Threatened and Endangered Species.

A Biological Assessment (BA) was prepared for the proposed action. In response to the BA, the U.S. Fish and Wildlife Service responded that the project may affect, but would not likely adversely affect, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf.

(7) Aquatic Life Forms.

The effects of the proposed action are expected to be minimal since the zone of turbidity around the project would be minor. Fish would be able to easily avoid the turbid areas.

(8) Land Based Life Forms.

Discharges are expected to have beneficial effects upon habitat for land based life forms by slowing the effects of erosion upon islands and associated vegetation. Protection of existing islands would promote maintenance of existing forage habitat for moose and other big game. Deposition of material behind anchored root wad logs and eco fences would provide potential for future forage growth for big game.

(9) Actions Taken to Minimize Impacts.

All work would be conducted during low-water flows in the Snake River. Low water generally occurs from October through April.

g. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination.

The current Quality Standards for Wyoming Surface Waters define a mixing zone as "a limited area or volume of a surface water body within which an effluent becomes thoroughly mixed with the water body." In addition, the standards state that compliance with water quality standards shall be determined after allowing reasonable time for mixing. For the activities proposed in this project, the mixing zone would be assumed to extend downstream 300 feet or to a point immediately upstream of the next tributary or sub-channel confluence (where channel braids reconnect). Turbidity monitoring would be accomplished at this point unless directed otherwise by Wyoming Department of Environmental Quality (DEQ) in the 401 Certification, if issued.

(2) Determination of Compliance with Applicable Water Quality Standards and Regulations.

(a) Section 401 Certification.

Section 401 of the Clean Water Act requires that applicants requesting a Federal license or permit to conduct activities that may result in a discharge in waters of the United States, provide to the licensing or remitting agency, a certification from the State that any such discharge complies with the applicable water quality standards. This evaluation will be provided to the Wyoming DEQ for their consideration in evaluating the project for compliance under Section 401 of the Clean Water Act.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water supply.

No effect.

(b) Recreational and Commercial Fisheries.

Turbidity generated by in-water work would have only a minimal effect upon fishing activity within and downstream of the project area. Additional aquatic habitat would result almost immediately following construction of spur dikes. Long-term benefits are expected from establishment of additional habitat and improved habitat from construction of side pools, channel stabilization pools, eco fences, rock grade control, and anchored root wad logs. Additional and improved habitat would provide potential opportunity for dispersal of existing fish species and increased numbers of fish per habitat unit within the project area. Recreational fisheries are expected to experience benefits from the project.

(c) Water Related Recreation.

The discharges of dredged and fill material are expected to have beneficial, long-term impacts upon overall water-related recreational activities. The proposed project is intended to prevent further erosion of islands and loss of vegetation and to facilitate terrestrial and aquatic habitat development. Incidental benefits to sightseeing, fishing, hunting, and rafting activities should occur. Rafters may experience temporary inconveniences until they become familiar with the locations of materials discharged to build the new structures.

(d) Aesthetics.

Stockpiled gravel, screened cobble, and discharged riprap for eco fences, spur dikes, and rock grade control would contrast with the surroundings. Stockpiling of gravel and screened cobble may not occur. However, if it does, visual impacts would be temporary because the material would only be in place a short period of time. Accumulation of woody debris on the piling and rock eco fences would cause their visual contrast to be short-term. Rock grade control would be unobtrusive due to the embeddedness of the material. Contrast of the spur dikes to existing surroundings would be evident to rafters and float fishermen travelling the river and to persons visiting areas that are publicly accessible. Anchored root wad logs would blend in with the setting.

(e) Parks. National Historical Monuments. National Seashores. Wilderness Areas. Research Sites. and Similar Preserves.

No effect.

(f) Actions to Minimize Impacts.

A public information campaign including signage and pamphlets would be implemented to inform river users of the intended project benefits and to alert river users of the construction and presence of the completed structures.

h. Determination of Cumulative Effects on the Aquatic Ecosystem.

The physical character of the Snake River in the project area has been affected in the past by the discharge of fill to construct levees and revetments. This action caused long-term adverse effects upon the river system. The effects include reduction of the width of the floodplain, increased flow velocities through the leveed sections, increased transport of bedload material through the area and erosion of islands, and destruction of wetland and riparian vegetation. Spawning habitat for Snake River fine-spotted cutthroat trout was reduced and the composition, and quality of riparian vegetation outside of the levees continues to change due to the changes in water circulation.

During the winter of 1998-99, Teton County Natural Resource District excavated approximately 6,000 cy of cobble and gravel to construct 3 off-channel pools near the Wilson Bridge. Teton County constructed five pile eco fences, totaling approximately 500 linear feet, on the gravel bars adjacent to the river. The eco fences were placed to trap woody debris, thereby causing the deposition of sediments upon which vegetation may become established. Approximately 1,600 linear feet of channel was also excavated near the bridge to compensate for reductions in flow capacity that would result from the deposition of sediments at the eco fences. The channel capacity excavation and off-channel pool work would have caused temporary non-beneficial effects upon benthic communities, however, recolonization of disturbed areas would occur soon after the disturbance. The long-term effect of Teton County's combined actions would be improvement in water quality due to decreased erosion and improvements in aquatic and terrestrial habitat.

Environmental restoration measures being proposed under the Jackson Hole, Wyoming, Environmental Restoration Project would also have both short- and long-term effects on the aquatic environment. Construction activities would cause minor, short-term impacts to water quality with temporary disturbance of the benthos. However, presence of the completed work would reduce erosion and provide long-term benefits to water quality. Recolonization of the benthos would occur soon after completion of work.

The project would provide primary beneficial cumulative effects by enhancing previously degraded aquatic habitat and by restoring portions of previously destroyed habitat. Rock grade control would provide immediate protection against erosion of the channel bottom. Eco fences and anchored root wad logs would trap other debris and help to reduce velocities within the levied stretch. Channel stabilization pools would also reduce flow velocities and reduce the quantity of bedload material being transported through the levied stretch. Secondary channels would help disperse flows and disperse suspended sediments throughout the floodplain, and off-channel pools would provide habitat for potential spawning and rearing. Bank barbs and kickers provide protection against erosion.

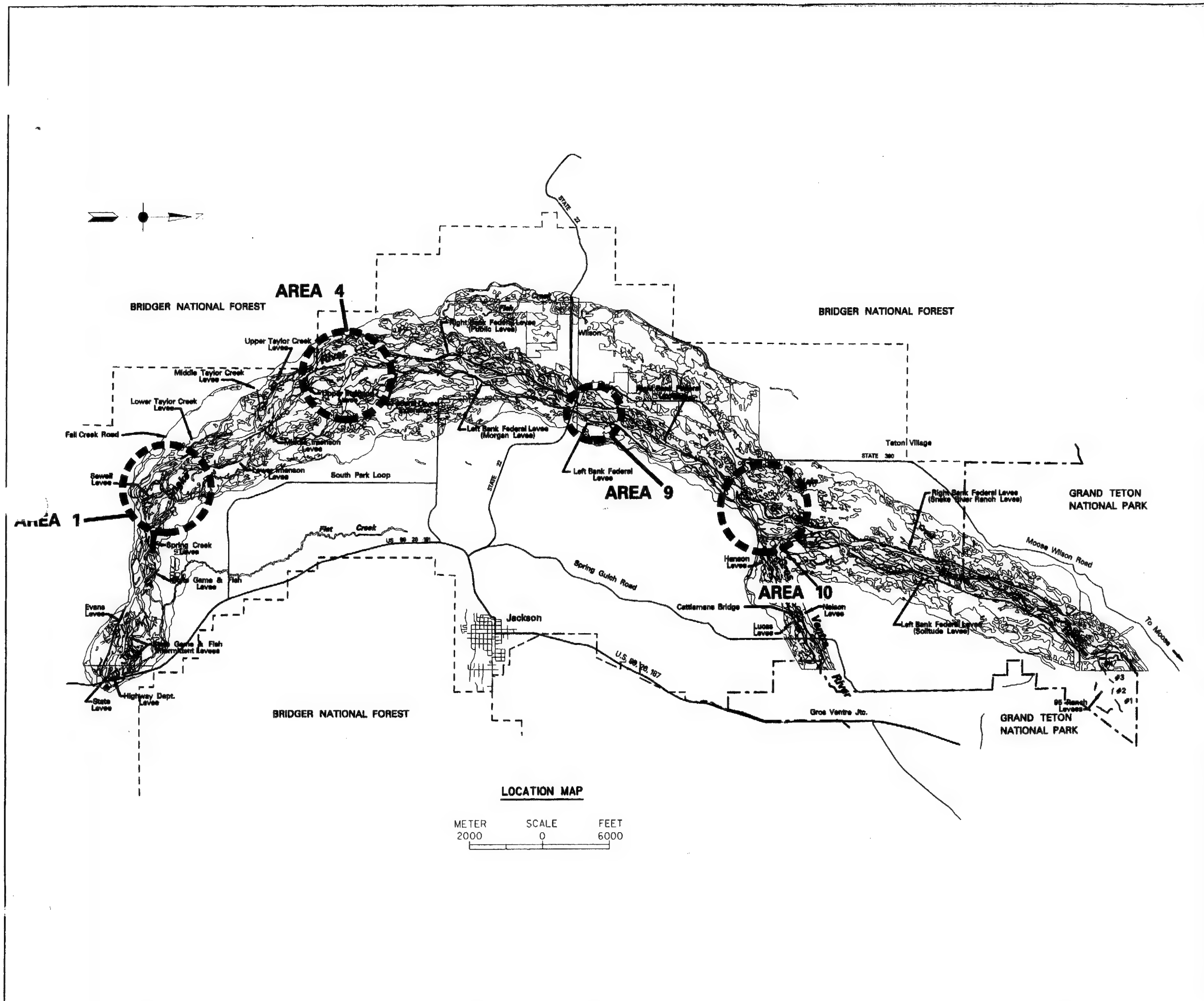
The collective effect of recent actions by Teton County to restore aquatic and terrestrial habitat and those measures proposed in the Jackson Hole, Wyoming, Environmental Restoration Project would reduce the overall adverse effect that past levee and revetment work has had upon the aquatic environment. Cumulatively, the proposed action would reduce erosion of islands and loss of wetland and riparian vegetation and create circumstances for the reestablishment of vegetation.

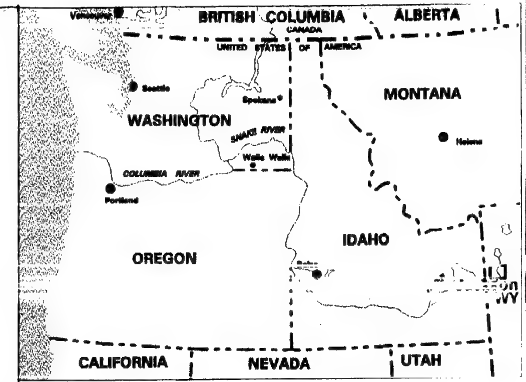
i. <u>Determination of Secondary Effects on the Aquatic Ecosystem</u>.

Sediments would deposit downstream of pile fences and anchored root wad logs, providing opportunity for establishment of vegetation. Establishment of

vegetation between the levees would help to slow velocities, thereby diminishing the potential for erosion. Scour areas would form around bank barbs and kickers providing resting habitat for Snake River fine-spotted cutthroat trout and other fish. No negative secondary effects are expected to result from the project.

PLATES





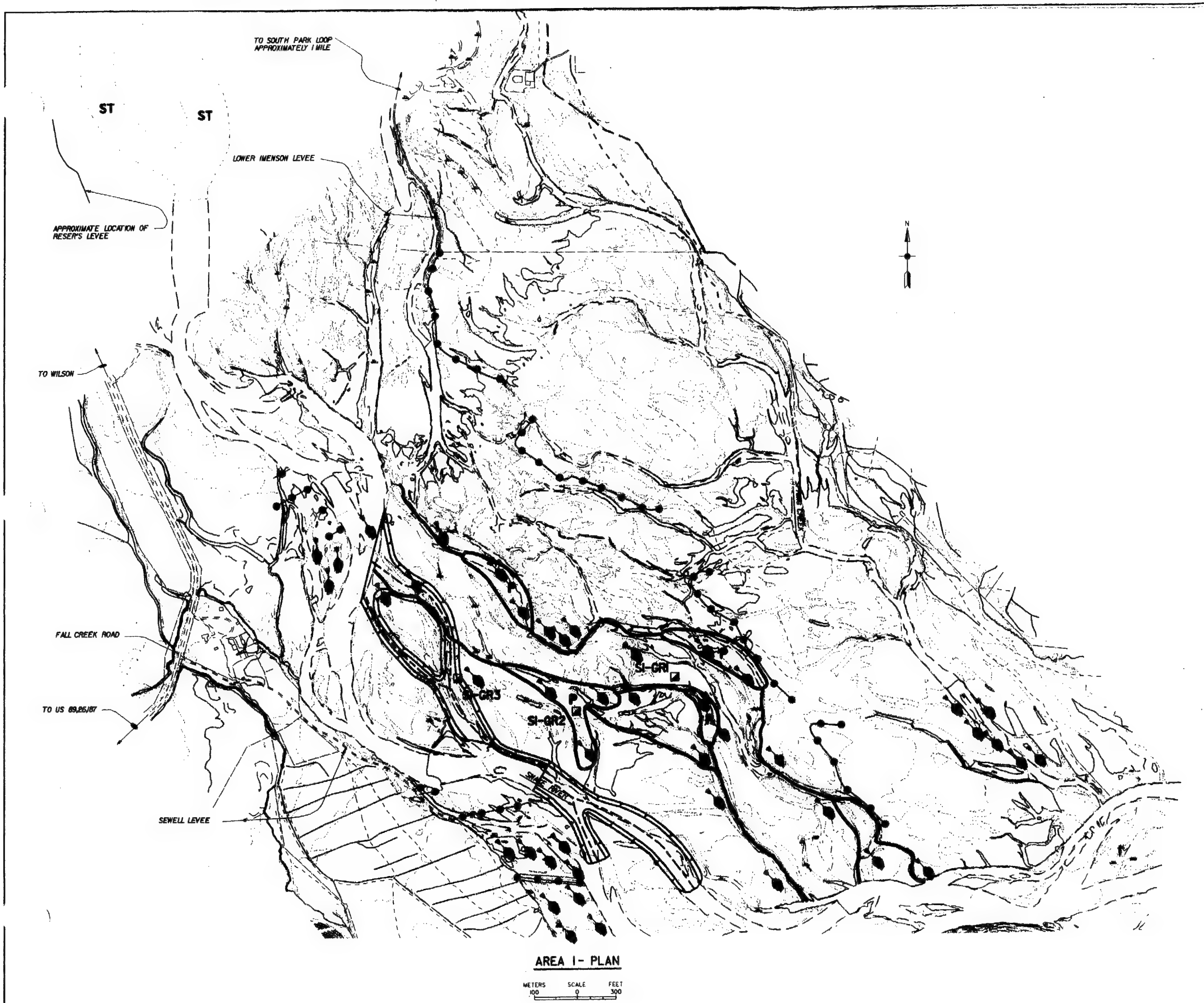
GEOGRAPHIC INFORMATION SYSTEMS
Corps of Engineers
Walla Walla District

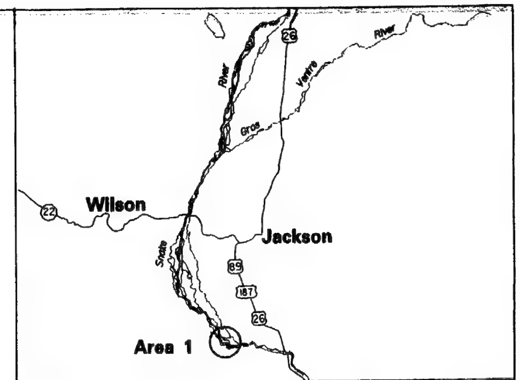
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA LOCATIONS

Plate 1





TEST PIT LOCATIONS
SEDIMENT TRAP ST
SIDE POOLS P
ECO FENCES
ANCHORED WOODY DEBRIS
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
LOW CHANNEL BOUNDARY

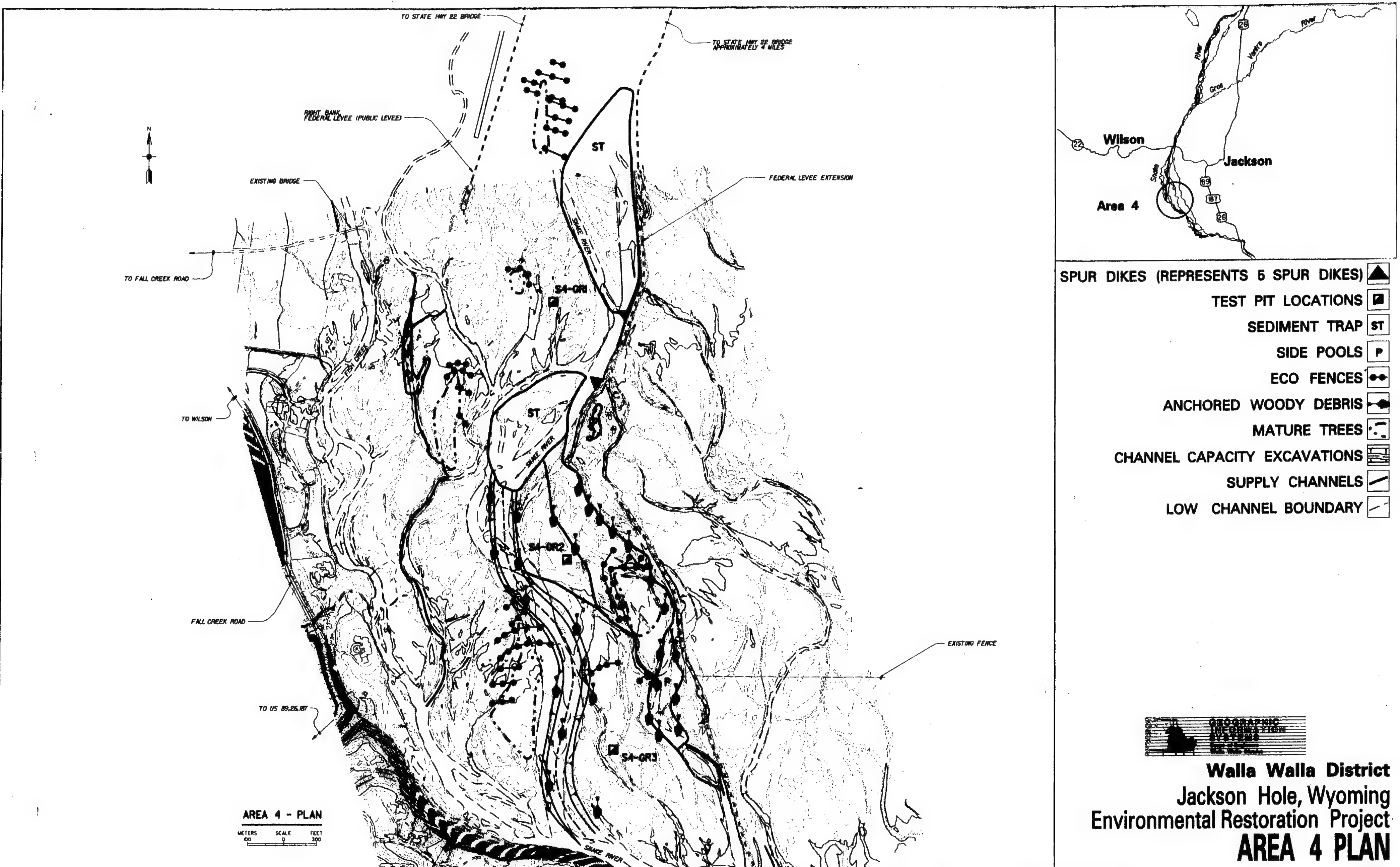
GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 1 PLAN

Plate 2



Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

AREA 4 PLAN

Plate 3

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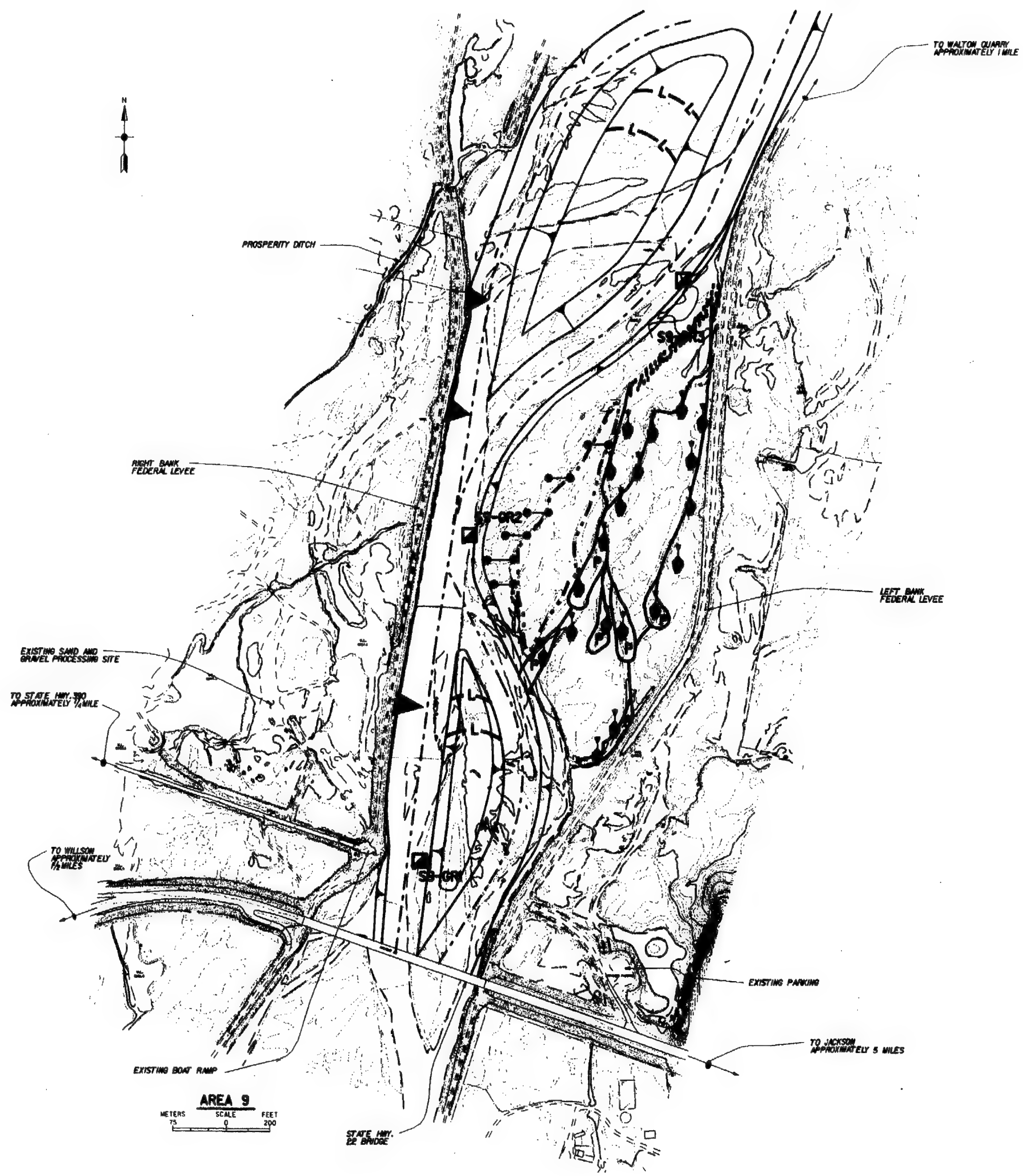
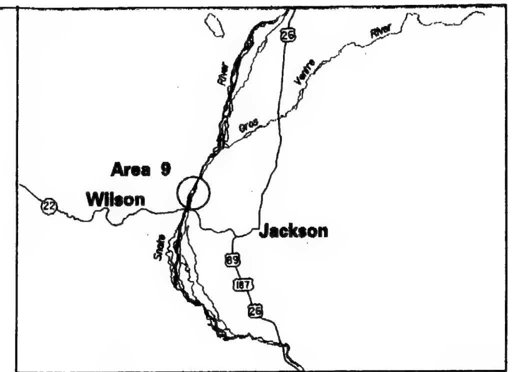




SPUR DIKES (REPRESENTS 5 SPUR DIKES)

TEST PIT LOCATION

SIDE POOLS

STAGGERED LOG PROTECTION

ECO FENCES

ANCHORED WOODY DEBRIS

ROCK GRADE CONTROL

MATURE TREES

CHANNEL CAPACITY EXCAVATIONS

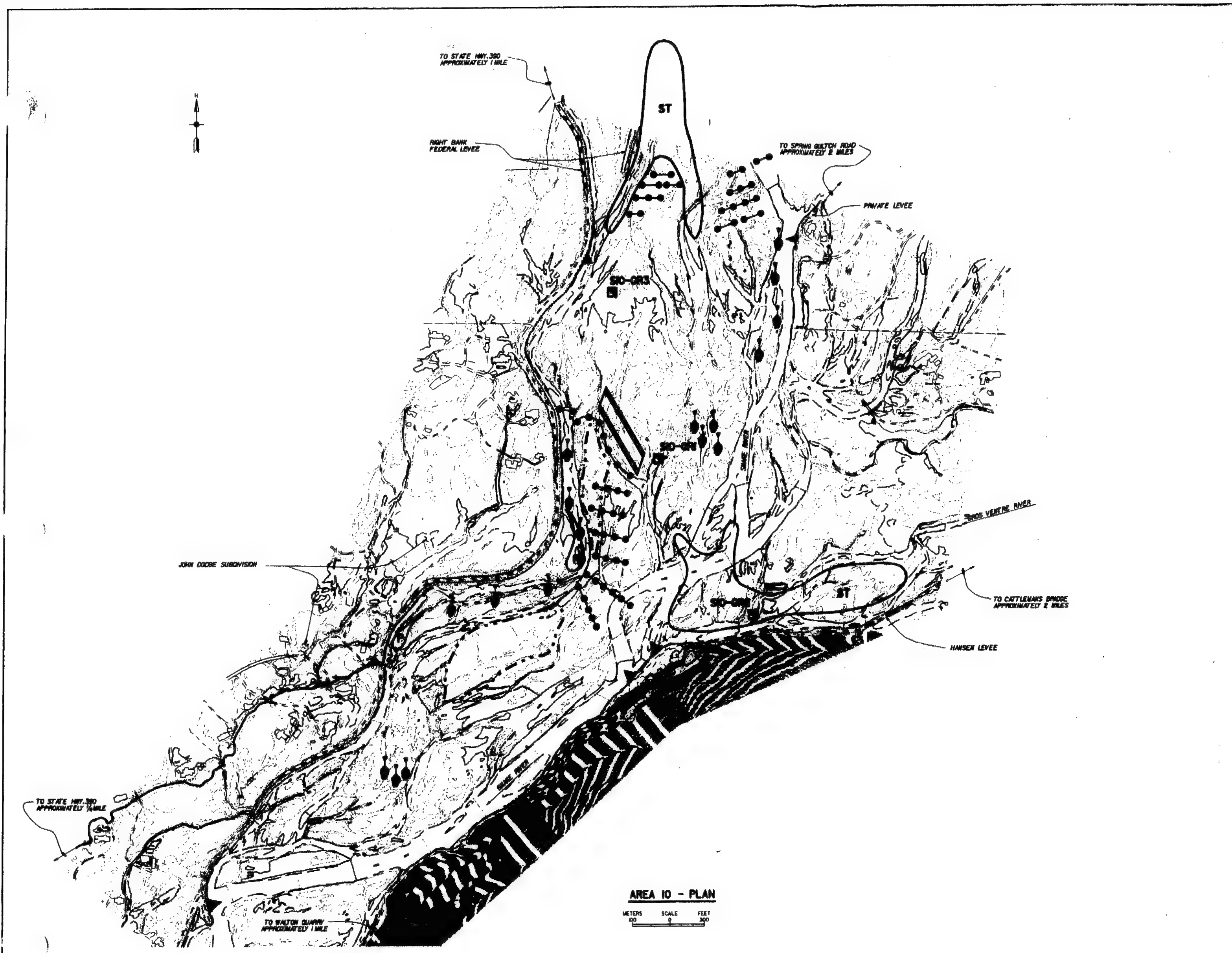
SUPPLY CHANNELS

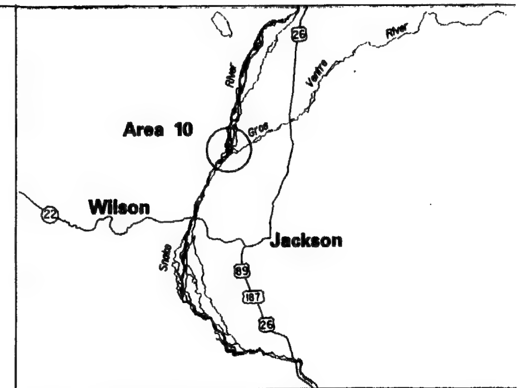
LOW CHANNEL BOUNDARY

Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 9 PLAN





SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATION
SEDIMENT TRAPS ST
SIDE POOLS P
ECO FENCES
ANCHORED WOODY DEBRIS
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
LOW CHANNEL BOUNDARY

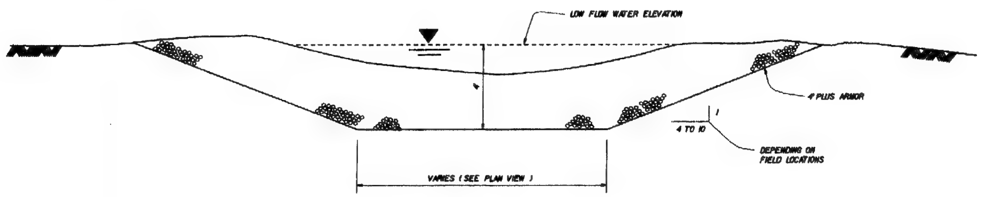
GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

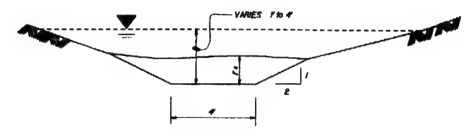
Jackson Hole, Wyoming
Environmental Restoration Project

AREA 10 PLAN

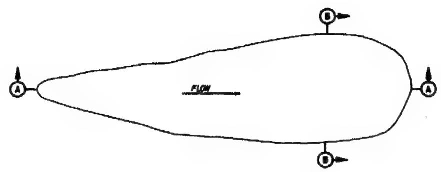
Plate 5



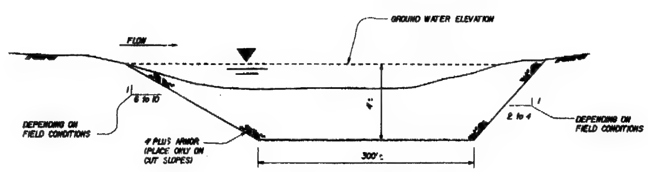
SECTION - SEDIMENT TRAP AND CHANNEL CAPACITY EXCAVATION TYP.



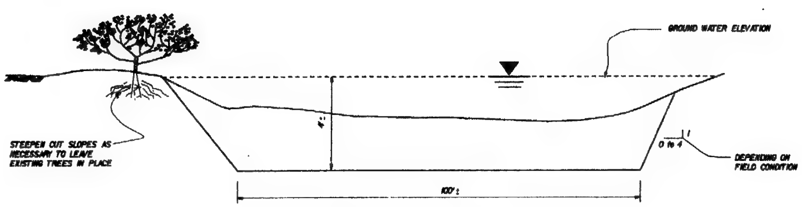
SECTION - SUPPLY CHANNEL TYP.



PLAN - POOL TYP.



SECTION A - POOL TYP.



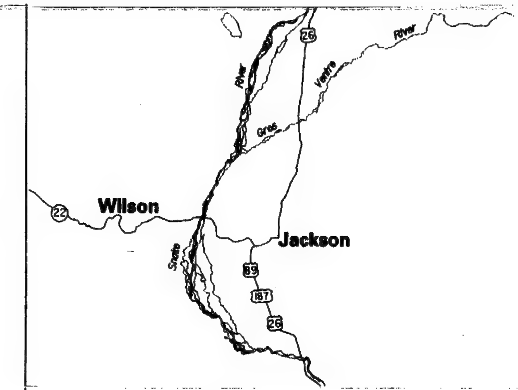
SECTION B - POOL TYP.

NOTES:

1. CUTS THAT INTERSECT EXISTING STRUCTURES SUCH AS LEVEES SHALL BE TERMINATED AT THE STRUCTURE.

2. CUT SLOPES WILL BE VARIED WITHIN THE RANGE SHOWN ON THE SECTIONS TO PROVIDE CHANNEL DIVERSITY.

3. WOODY DEBRIS WILL BE ANCHORED ON CUT SLOPES. APPROXIMATELY ONE ROOT WAD FOR EVERY 60' OF POND PERIMETER.



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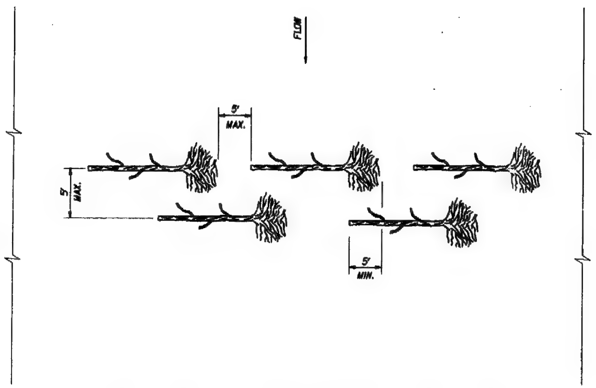
Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

FLOW IMPROVEMENTS - DETAILS

Plate 9

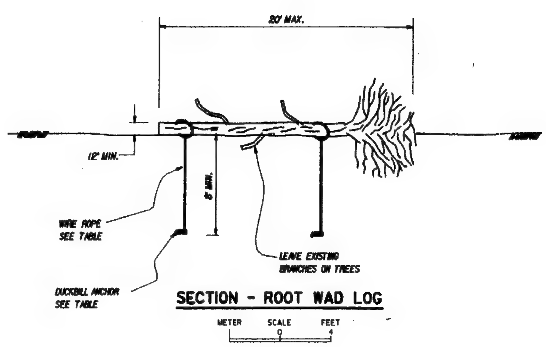


PLAN - STAGGERED ROOT WAD LOG PLACEMENT

NOT TO SCALE

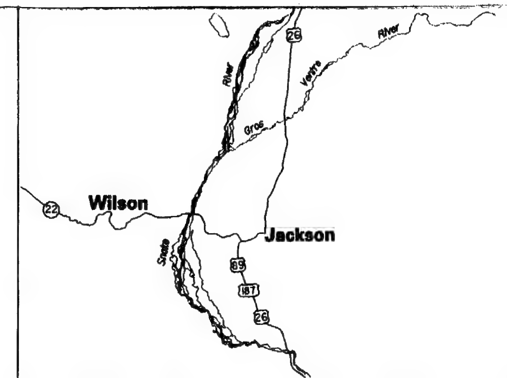
NOTES:

LOGS WOULD BE RANDOMLY STAGGERED TO ALLOW FOR SHORTER LENGTH ROOT WAD LOGS. SPACING AND OVERLAPPING REQUIRMENTS MUST BE FOLLOWED AS SHOWN.



SECTION - ROOT WAD LOG

METER SCALE FEET



GEOGRAPHIC INFORMATION SYSTEMS

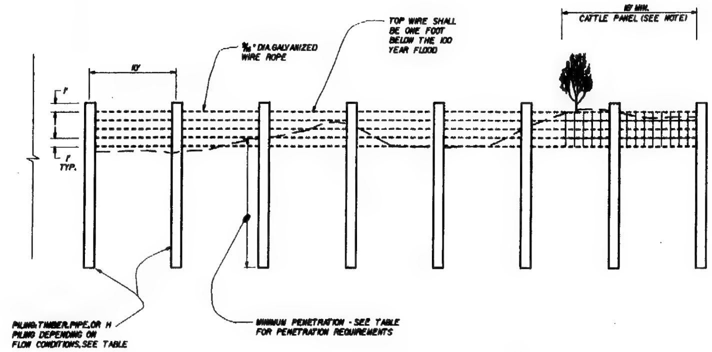
Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

ANCHORED ROOT WAD LOGS - DETAILS

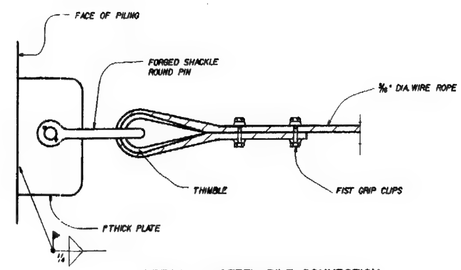
Plate 7



DETAIL - PILE ECO FENCE

METERS SCALE FEET

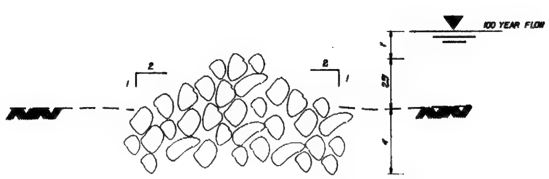
NOTE:
IN AREAS ADJACENT TO WOODED ISLANDS KEY BRUSH FENCE 16' INTO ISLAND AND ATTACH CATTLE PANEL.



DETAIL - STEEL PILE CONNECTION

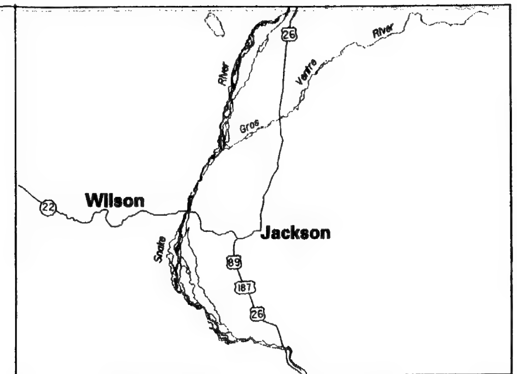
NOT TO SCALE

NOTE:
INSTALL PILE CONNECTION AT EVERY FIFTH PILING AND END PILING. THREAD WIRE ROPE THROUGH INTERIOR PILING.



TYPICAL SECTION - ROCK ECO FENCE

NOT TO SCALE



GEOGRAPHIC INFORMATION SYSTEMS

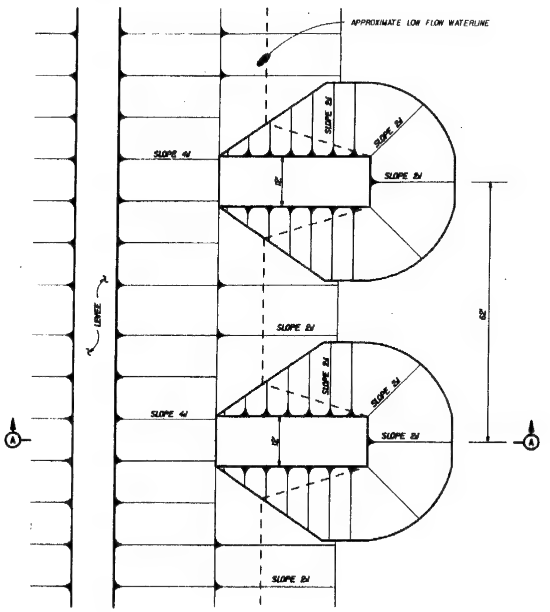
Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

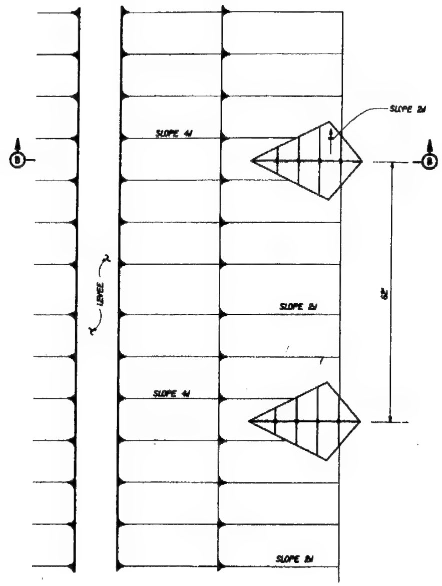
ECO FENCE - DETAILS

Plate 8



PLAN - KICKERS

METERS SCALE FEET
3 0 10

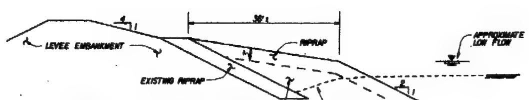


PLAN - BANK BARB

METERS SCALE FEET
3 0 10

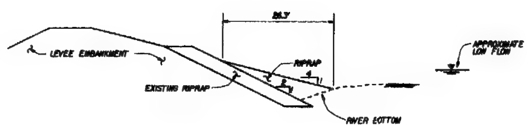
SECTION - ROCK GRADE CONTROL

METERS SCALE FEET
3 0 10



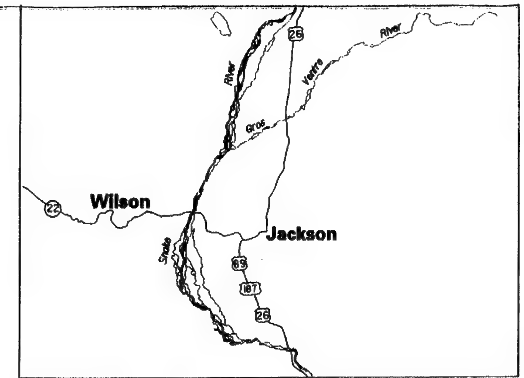
SECTION A - KICKERS

METERS SCALE FEET
3 0 10



SECTION B - BANK BARB

METERS SCALE FEET
3 0 10



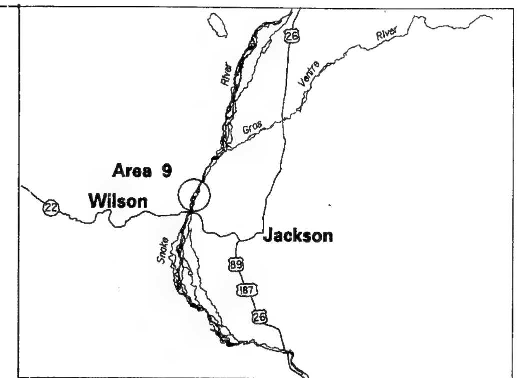
GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

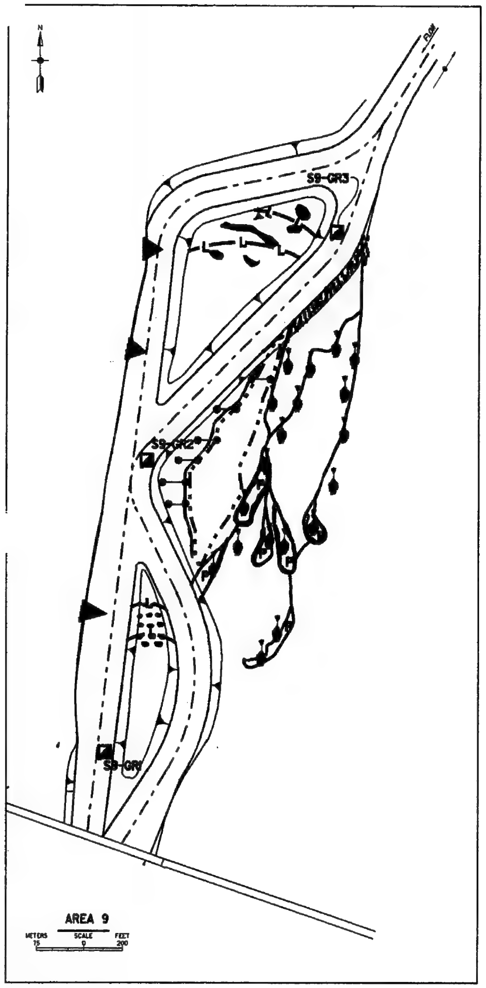
Jackson Hole, Wyoming
Environmental Restoration Project

SPUR DIKE - DETAILS

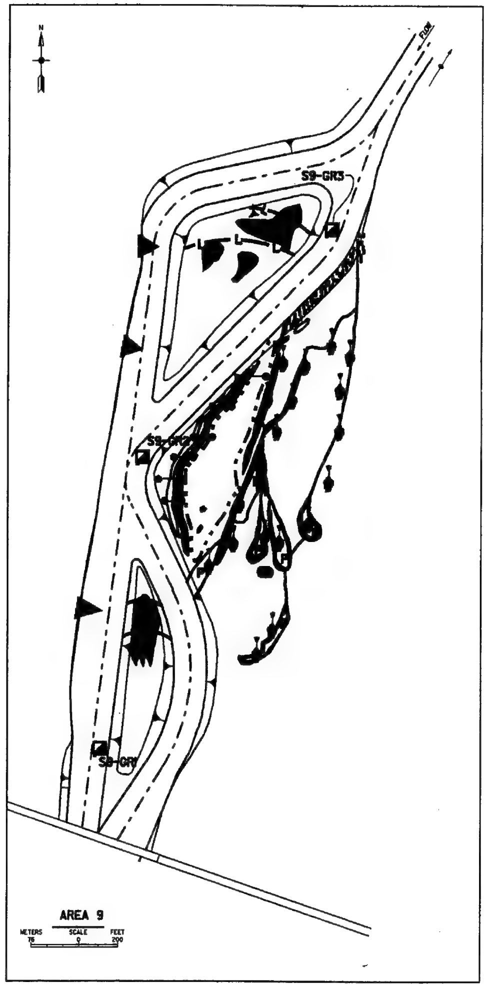
Plate 9



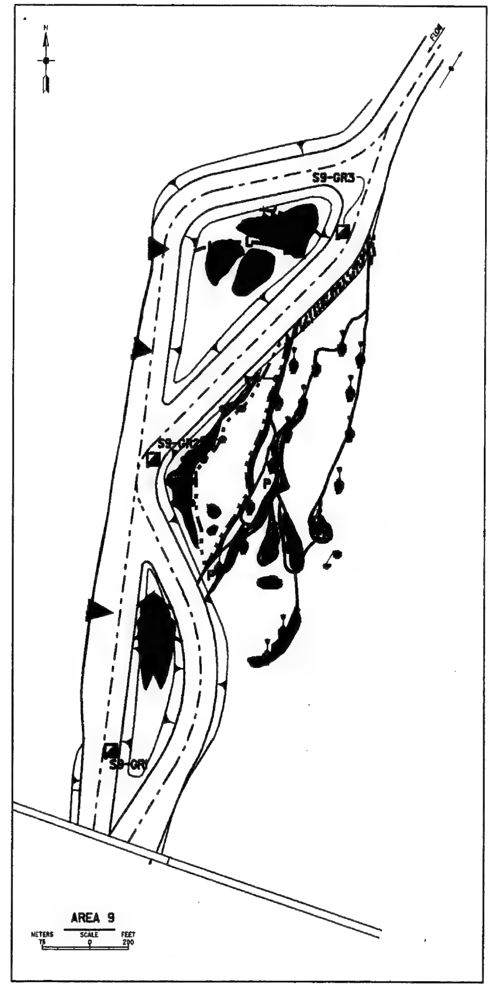
SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATION
SIDE POOLS
STAGGERED LOG PROTECTION
ECO FENCES
ANCHORED WOODY DEBRIS
ROCK GRADE CONTROL
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
PALUSTRINE SHRUB/SCRUB (PSS)
PALUSTRINE FOREST (PF)



5 YEAR



25 YEAR



50 YEAR

Walla Walla District
Jackson Hole, Wyoming
Environmental Restoration Project

AREA 9 PROJECTED VEGETATION CHANGES

Plate 10

Appendix F
to the Environmental Assessment

JACKSON HOLE, WYOMING ENVIRONMENTAL RESTORATION PROJECT

MONITORING PLAN

April 2000

1.0 BACKGROUND

Levees constructed under the Jackson Hole, Snake River, Wyoming levee project reduce the potential for flood damage within adjacent areas of the Snake River valley. The levees also significantly changed the physical character of the river system and contributed to the loss of environmental resources through reduction of the floodplain and reductions in habitat diversity. Effects include changes in channel configuration that have eliminated natural braiding and reduced the number and size of islands. High velocity flows erode the river channel, islands, and vegetation along the banks and on islands. Effects to aquatic habitat include reduction of the following: low energy resting habitat, in-stream large woody debris, vegetative cover, and high quality tributary spring creeks essential to some species for spawning. Effects to riparian habitat include the reduction of shrub-willow/cottonwood habitat important in the life cycles of many species of wildlife.

The Jackson Hole, Wyoming Environmental Restoration Study was authorized to investigate methods to restore lost fish and wildlife habitat resulting from construction, operation, and maintenance of the Jackson Hole levee project, including levees constructed by non-Federal interests, and methods to reduce the cost of operating and maintaining the levees. Measures identified by the study focus on methods to dissipate or redirect the energy of high velocity flows in order to reestablish aquatic and terrestrial habitat. These measures include construction of eco-fences, sediment traps, spur dikes (bank barbs and kickers), and off channel pools with connecting side channels. Detailed descriptions of all restoration features are presented in the main feasibility report.

2.0 PURPOSE

The purpose of this Monitoring Plan is to assess the effectiveness of the restoration features on aquatic and terrestrial resources. Monitoring will focus on the functional performance of the restoration tools and on the effects on aquatic and terrestrial habitat. Monitoring would also identify the need for maintenance on various structures. Results obtained through monitoring will enable the Corps of Engineers and local sponsor, through coordination with local agencies, regulatory authorities, landowners, and other interests, to make informed decisions concerning management of the project to achieve planned performance goals. The monitoring plan will also build an information base to support future restoration decisions regarding the design and performance of the restoration measures.

3.0 MONITORING PROCEDURES

Monitoring procedures have been organized in this plan to differentiate between project performance and maintenance requirements. Project Performance monitoring will document fish and wildlife habitat conditions at construction sites prior to construction and will assess the long-term changes in riparian and aquatic

habitat. Maintenance monitoring will be performed to assess maintenance needs for each restoration tool. Monitoring for the Progressive Plan will be performed in a similar manner to Initial Plan monitoring.

3.1 Project Performance Monitoring

Monitoring of terrestrial resources would focus upon the effects of the restoration project on riparian vegetation and wildlife habitat. Aquatic resources monitoring would identify effects of restoration tools upon cutthroat trout habitat. A Corps representative would conduct this monitoring.

Vegetation transects and Habitat Evaluation Procedures (HEP) would be used to monitor for signs of vegetative succession toward the palustrine scrub-shrub (dominated by willows) and palustrine forest (dominated by cottonwood) ecotypes. Models for yellow warbler and song sparrow would be used. These models work well for riparian vegetation. Habitat Evaluation Procedures (HEP) were utilized during the project study to identify existing vegetation and assess changing conditions in vegetation loss or gain. Vegetation transects depict trends by the change in cover and measure site specific changes. HEP shows the change in habitat units and measures site specific and regional changes.

Monitoring efforts occurring during the first five years of monitoring would be documented and presented a Project Performance Report. The report would document monitoring efforts and results for all four of the initial restoration sites. Periodic reports will also be written for monitoring during the Progressive Plan monitoring years.

Vegetation Transects

The vegetation transects will be 30 meters long, running parallel to the eco-fences. Three layers of vegetative information would be recorded along this transect. A transect would start in the area downstream of the eco-fence and proceed to the adjacent upland. The transect may be extended to 60 meters if needed. All vegetation cover percentages would be recorded by line intercept. Herbaceous vegetation, shrubs, and trees will have cover percentages recorded this way. Photos would be taken from one end of the transect looking toward the other end of the transect. Three photos would be taken at each end, with each series generally consisting of one photo-view perpendicular to the transect and the remaining two offset by approximately 15-degrees. Other transects would be run through log placements and along secondary channels. At least two transects in each of these areas would be recorded. Transects would be measured and recorded during mid-July each year.

Aerial Photography and Cover Typing

Aerial photography would be obtained for each of the constructed sites when available and in the fifth year of monitoring. Cover types would be mapped and measured over all of the work sites. Palustrine forest and palustrine scrub-shrub types would be singled out for use with the HEP. Field HEP parameters would be measured at all work sites during the summer of the year aerial photography is taken. Field work would use the same methodology for the abbreviated HEP performed in 1996 (Yellow Warbler and Song Sparrow were the indicator species used for this analysis). Habitat suitability indices (HSI) would be calculated for all palustrine forest and palustrine scrub-shrub habitats. Habitat units would be calculated by multiplying the HSI value by the area of habitat.

Cutthroat Trout Over-wintering Habitat Evaluation

Cutthroat trout over-wintering habitat will be estimated for each initial restoration site during the first and fifth years of monitoring. If the Progressive Plan is implemented, pre-construction baseline habitat data will be collected. Future habitat measurements will be conducted periodically to assess the effectiveness of the restoration tools toward maintaining over-wintering habitat. The habitat evaluation methods will estimate the quantity and quality of over-wintering pool habitat available for adult and juvenile cutthroat trout in the selected study sites during the critical winter period. Data gathered in this evaluation will be incorporated into the Project Performance Report.

The same over-wintering pool habitat evaluation procedures used in 1998 for the pre-construction evaluation will be used, including photo documentation at all survey point locations. The evaluation of the habitat types and attributes being considered will allow for a determination of habitat benefits gained through this project. Evaluations will be carried out in the fall during low flow conditions, usually in early October. Low flow conditions are important because over-wintering habitat during low flow is one of the most critical limiting factors on cutthroat in the upper Snake River.

3.2 Maintenance Monitoring

Maintenance monitoring will assess the performance of restoration. A Corps representative would conduct Maintenance monitoring. All structures will be photographed annually during monitoring and immediately following implementation of any maintenance measures that may result. Hydrologic monitoring will track the performance of the tools in relation to their intended purpose and track the effects of river flows upon the restoration tools.

When indicated, the status of restoration effects and performance of all features would be facilitated by dated photographic documentation. Photographic documentation would include the establishment of photo points throughout each project site. The location of the photo points and field of view would be mapped

and location markers placed in the field where possible. This may be done with permanent stakes and a compass, or other means that would insure consistent photographic fields of view throughout the monitoring period. All construction sites would be photographed prior to initiation of construction. All constructed features would be photographed upon the completion of construction to serve as a basis for future comparison of vegetative growth and sedimentation as appropriate.

Observed damages, required repairs, and observed physical changes in the various restoration features will be presented in an annual Maintenance Monitoring Report. The report would document maintenance monitoring efforts occurring during the 5 years of cost-shared monitoring. The report will include results observed, photographs, and subsequent implemented maintenance.

4.0 MONITORING COSTS

The cost of project performance monitoring and maintenance monitoring would be shared between the Corps and local sponsor and is limited to 4 per cent of the total construction cost. The final monitoring plan will be identified for each construction area during the PED phase.